AMERICAN ENGINEER AND RAILROAD JOURNAL.

AUGUST, 1900.

CONTENTS.

"NORTHWESTERN" TYPE PASSENGER LOCOMOTIVE.

Chicago & Northwestern Railway.

The Schenectady Locomotive Works are building six most interesting passenger locomotives for the Chicago & Northwestern Ry., one of which was exhibited at the Saratoga conventions and is now in service. The wheel arrangement is that of the Atlantic type, but the features of the rear end are so unusual as to justify giving it another name, the "Northwestern" type. This engine has the largest amount of heating surface ever given to an engine of this wheel arrangement, and the grate area, due to the wide firebox, is the largest of which we have record, for a design intended exclusively for soft coal. We consider this engine as a remarkable step in the development of powerful fast passenger locomotives, and in order to do it justice we shall take it up again in our columns when performance records have been made, with a discussion of the prominent features of the design. At this time attention will be confined to the general features.

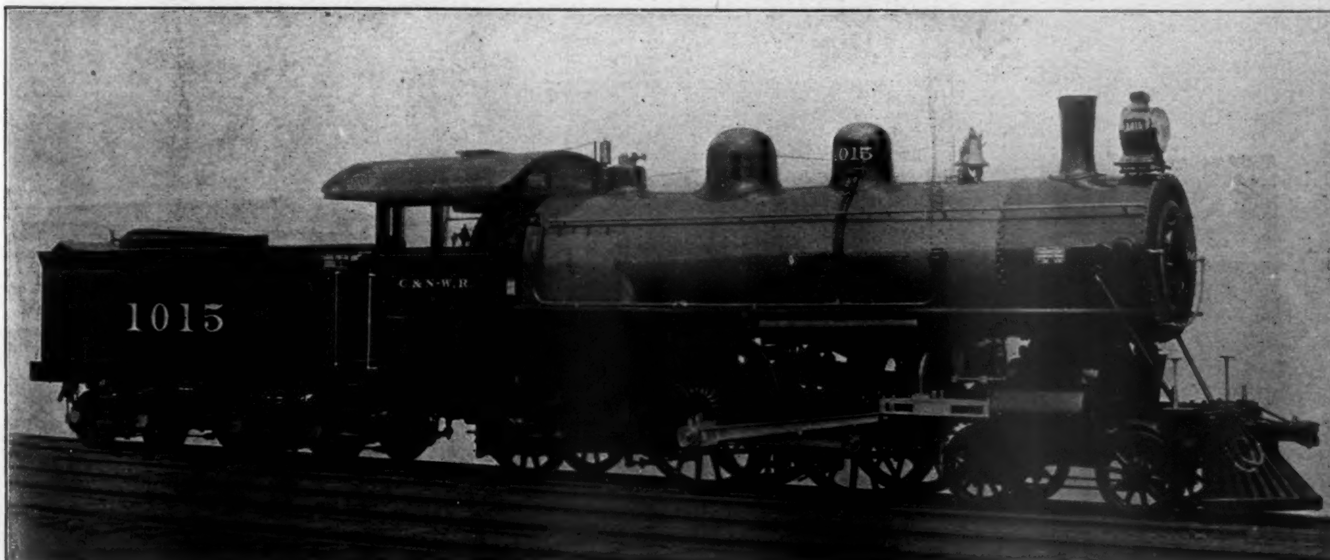
The chief departure from the usual Atlantic type is in the frame arrangement at the back end and the use of outside journals for the trailing wheels. Wider support for the firebox than can be had with the Atlantic type was desired. A wide firebox with the usual arrangement of frames causes considerable overhang of the mud ring at the sides, and with outside journals and supplemental frames the supports are placed directly under the mud ring at its extreme width. The purpose of this is to steady the engine and prevent excessive vibratory movements at high speeds. This design also simplifies the difficulties of getting in a good ashpan, and it removes the trailing journals from the heat of the ashes. The wide firebox is the special feature of this engine. It gives a large grate area without excessive length, and it may be increased in width if desired. In this respect the engine is capable of further growth and increase of power.

The valves are of the piston type with inside admission and the motion is direct. In every particular the engine represents great care in design and construction, and its influence upon future practice in fast passenger locomotives may be expected to be very strong in favor of larger grates. In fact we believe it to be the forerunner of a general introduction of wide grates for soft coal engines hauling heavy passenger trains. It is, therefore, considered one of the most important of recent American locomotives. Messrs. Quayle and Henderson, as well as the Schenectady Locomotive Works, are congratulated upon this production.

The following particulars have been furnished by the builders:

"North-Western" Type Locomotive.
General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal
Weight in working order	160,000 lbs.
Weight on drivers	90,000 lbs.
Wheel base, driving	7 ft. 0 in.
Wheel base, rigid	16 ft. 0 in.
Wheel base, total	26 ft. 9 in.
Wheel base, total of engine and tender	54 ft. 8¾ in.



"NORTHWESTERN" TYPE PASSENGER LOCOMOTIVE.

CHICAGO & NORTHWESTERN RAILWAY. SCHENECTADY LOCOMOTIVE WORKS, *Builder*.

Weights: Total of engine............160,000 lbs.; on drivers...... 90,000 lbs.; total, engine and tender, 20',000 lbs.
Wheel base: Driving............7 ft.; total of engine........ 26 ft. 9 in; total, engine and tender............54 ft 8¾ in.
Cylinders: 20 x 26 in. Wheels: Driving ....80 in.; truck ....36 in.; trailers........ 48 in.
Boiler: Straight, radial stays, diameter...... 68⅝ in; boiler pressure...... 200 lbs.
Firebox Length ....102⅛ in.; width ....65¼ in.; depth, front .... 76¼ in.; depth, back ...... 67 in
Grate: Rocking; area...........46.2 sq. ft.; Tubes 338 2-in .... 192 in. long.
Heating surface: Tubes..... 2,816.9 sq. ft.; water tubes............28.27; firebox............170.7; total ....3,015 sq. ft.
Tender: Eight-wheel; tank capacity............5,200 gals. water, 8 tons coal.

Cylinders.

Diameter of cylinders	20 in.
Stroke of piston	26 in.
Horizontal thickness of piston	5⅝ in.
Diameter of piston rod	3¼ in.
Size of steam ports	1⅝ in.
Size of exhaust ports	2¾ in.
Size of bridges	1⅞ in.

Valves.

Kind of valves	Piston
Greatest travel of slide valves	6 in.
Outside lap of slide valves	1¼ in.
Inside lap of slide valves	⅞ in.
Lead of valves in full gear	Line and line, 0 in.
Kind of valve stem packing	Hemp

Wheels, Etc.

Diameter of driving wheels outside of tire	80 in.
Material of driving wheel centers	Cast steel
Driving box material	Cast steel
Diameter and length of driviing journals	9 in. dia. by 12 in.
Diameter and length of main crank pin journals (main side 6¾ by 4½ in.)	6 in. dia. by 6 in.
Diameter and length of side rod crank pin journals	4½ in. dia. by 4 in.
Engine truck, kind	Four-wheel, swing bolster
Engine truck, journals	6 in. dia. by 10 in.
Diameter of engine truck wheels	36 in.
Kind of engine truck wheels	"National" steel tired

Boiler.

Style	Straight
Outside diameter of first ring	68⅜ in.
Working pressure	200 lbs.
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox	11/16 in., ½ in., 7/16in.
Firebox, length	102⅛ in.
Firebox, width	76¼ in. F; 67 in. B.
Firebox, depth	76¼ in. F.
Firebox, material	Carbon steel
Firebox plates, thickness	sides ⅜ in., back ⅜ in., crown ¾ in., tube sheet ½ in.
Firebox, water space	front 4 to 5 in., sides 3½ to 5½ in., back 3½ to 4½ in.
Firebox, crown staying	Radial
Firebox, staybolts	Taylor iron
Tubes, material	Charcoal iron No. 12
Tubes, number of	338
Tubes, diameter	2 in.
Tubes, length over tube sheets	192 in.
Fire brick	Supported on 4 water tubes
Heating surface, tubes	2,816.91 sq. ft.
Heating surface, water tubes	28.27 sq. ft.
Heating surface, firebox	170.7 sq. ft.
Heating surface, total	3,015.88 sq. ft.
Grate surface	46.2 sq. ft.
Grate, style	Rocking, C. & N.-W. style
Ash pan, style	Sectional
Exhaust pipes	Single
Exhaust nozzles	4¾ in., 5 in., 5¼ in. dia.
Smoke stack, inside diameter	16½ in. at top, 14 in. near bottom
Smoke stack, top above rail	15 ft. 1⅝ in.
Boiler supplied by	Two Monitor injectors, size No. 10

Tender.

Weight, empty	43,200 lbs.
Wheels, number of	8
Wheels, diameter	36 in.
Journals, diameter and length	5 in. dia. by 9 in.
Wheel base	16 ft. 10 in.
Tender frame	10-in. steel channels
Tender trucks	4-wheel, channel iron, center bearing and side bearings on both trucks
Water capacity	5,200 U. S. gallons
Coal capacity	8 tons

THE CONSULTING ENGINEER AND SHOP PLANS.

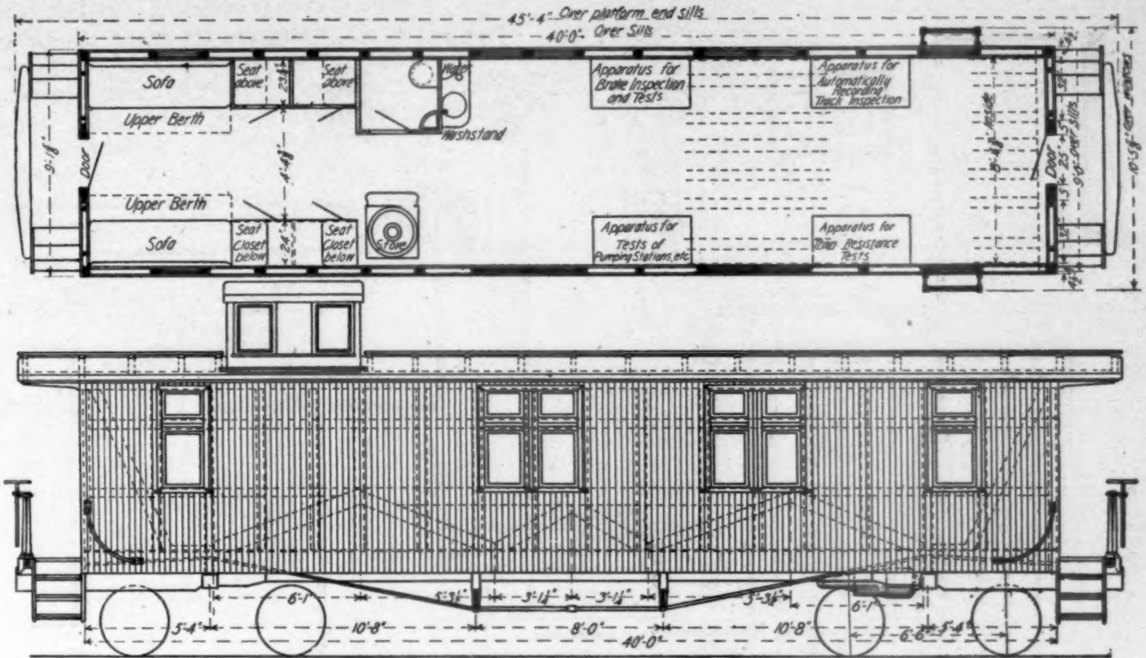
In summing up the progress which has been made during the past ten years in various branches of railroad work, that of shop arrangement and equipment has not had its share of attention. A great deal has been achieved in shop improvement and the electric motor seems destined to work still more changes, not only in arrangement of buildings and machinery, but even in the matter of location of shops. A few years ago motive power department draftsmen were able to plan and carry out extensive shop improvements. The problems were comparatively simple before it became necessary to decide upon the methods of power distribution, the capacities of generators with reference to those of the motors, the most favorable selection of units for individual and for group driving, the sizes of groups, the determination of voltage and the systems of wiring. Now also the gas engine and steam turbine come in for attention in the power-house question. These questions and those of shop heating, ventilation and lighting may all be settled indifferently well by consultation with those who are prepared to contract for the complete equipments of the various kinds, but there is a better, a more satisfactory and almost necessary method, entrusting all of the plans and details to a specialist, a consulting engineeer who has the necessary experience and information and can bring to bear a knowledge which no one else may hope to possess. The tendency to employ a consulting engineer for the plans of new shops is a marked step in advance which should be recognized. There are three good reasons why he should be called upon. The mechanical officers are now overloaded, and while they are always ready to do this work, something else must suffer if the new shops receive the attention they require. The questions call for a wider special kind of experience than the motive power man can be expected to have, and last and most important, the right kind of consulting engineers for this work are now available. Railroad managements will do well to take these facts into consideration in connection with new shops. It is not necessarily the best arrangement from a steam engineering standpoint that will give the best results, but rather a balance of a large number of very peculiar factors and the fact that they will affect the cost of the repairs of rolling stock for many years should lead to the right view in regard to the engineer's fee.

BETTER "FOOTPLATES" ARE NEEDED.

Methods for fastening the rear ends of locomotive frames need more attention as the capacities of locomotives increase. The old-time, heavy cast-iron footplate is now seriously missed as a factor in holding the frames against the tugging action caused by the sudden application of high pressure against large pistons. As soon as a little motion is produced between these parts looseness and wear begin, and then frames and cylinders begin to break and saddles loosen from the smokebox. The back ends of the frames need to be more rigidly secured than ever before. The single or double bars across the frames at the ends with a gained joint are insufficient in stiffening capacity, and they are often put together with a joint which is almost impossible to fit with accuracy when built and is sure to work loose in service. When once loosened the stresses which should be met here are transferred to some other point. The part which now takes the place of the footplate should have ample bearing surfaces and plenty of bolts. It should be made with a view of securing a tight, firm fit, and whether bolted or riveted, precautions should be taken to avoid the shocks of pulling and buffing. A good way to accomplish this is to provide a spring buffer between the engine and tender which will keep the tender draft link always in tension. If the slack of this link is always taken up the whole frame system of the engine will be relieved from a lot of destructive stresses. It may at first appear impossible that excessive lead of the valves should exert an influence upon the rear frame connections, but it has recently developed that this is the case. It should be remembered that steam pressures have been rising as weights have increased, and excessive lead with 200 or 225 lbs. boiler pressure subjects the whole engine to a series of violent shocks. Framing and bracing must be strong to resist them. These facts are brought to mind upon seeing heavy engines built, as they are now being built, with only two relatively small wrought-iron braces across the back ends of the frames. This is not believed to be a good way to save weight.

Scale is generally removed from boiler flues by "rattling" them in a tumbling barrel or by machines to cut through the deposit and grind it off. An improved and very convenient method used at the Sayre shops of the Lehigh Valley is recorded by the "Railroad Gazette." The flues are heated to a cherry red in a long furnace and then dropped into cold water. The difference in the contraction of the tube and the scale causes the scale to crack off and leave the tubes. It is found to be cheaper than the other methods at Sayre.

Professor W. F. M. Goss has been chosen Dean of the engineering schools of Purdue University, a merited honor upon which we join his numerous friends in congratulations.



Railway Test Car, Illinois Central R. R. and University of Illinois.
Fig. 1.—Side View and Plan.

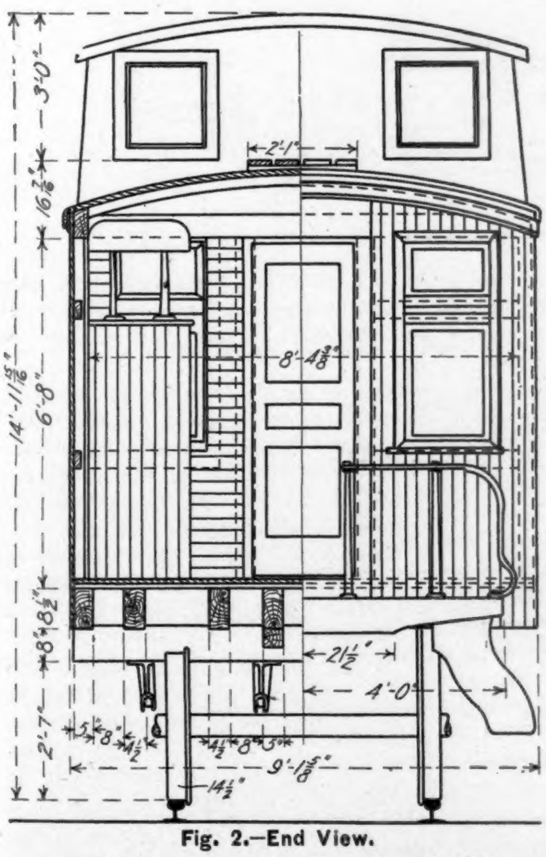


Fig. 2.—End View.

TEST CAR OF THE ILLINOIS CENTRAL RAILROAD AND THE RAILWAY MECHANICAL ENGINEERING DEPARTMENT OF THE UNIVERSITY OF ILLINOIS.

By Edward C. Schmidt,

Instructor in Railway Mechanical Engineering.

This car is now almost completed at the Burnside shops of the Illinois Central Railroad at Chicago. It will be owned and operated jointly by the Illinois Central Railroad and the Railway Mechanical Engineering Department of the University of Illinois, the car being built by the former and the apparatus and other equipment by the latter. It is designed for general railroad experimental work and will be adapted for the following purposes, for each of which it has its special equipment: Measurement of train resistance; autographic track inspection, locomotive road tests and air brake tests.

Hydraulic transmission of the pressure and motion has been adopted for the apparatus for dynamometric work and for track inspection; the latter, however, is not being at present installed. The car has been designed under the direction of Mr. Wm. Renshaw, Superintendent of Machinery, Illinois Central Railroad; Professor L. P. Breckenridge of the Department of Mechanical Engineering of the University of Illinois, and the writer. The car itself has been specially designed for this work and is shown in Figs. 1 and 2. It has been made particularly heavy, in order to withstand the usage it will receive in the heaviest freight service.

It is 45 ft. 4 in. in length and 40 ft. over the end sills, which is as long as is compatible with the necessary stiffness and rigidity. It is 8 ft. 4⅜ in. wide inside, 9 ft. 1⅝ in. outside, with an extreme width of 10½ ft. over the observation windows. About 15 ft. in the rear end is occupied by the berths, lockers, closets and toilet-room, leaving 25 ft. working space in which are placed the tables and instruments. The lookout shown in the rear of the car affords facilities for observing the handling of the train, and in it are placed the push-buttons controlling the signals to the operators below, and also the pens which mark on the dynamometer record the location of mile posts, stations, curves and grades. The projecting windows at the front end also provide means for watching the train and engine. The next three figures show the general arrangement and some of the details of the apparatus used in experiments for the measurement of train resistance, which constitutes at present the more important part of the equipment, the track inspection apparatus not being designed as yet. Fig. 3 is a diagram showing the various parts of the apparatus in their relations to one another. The pressure due to the pull on the draw-bar is taken in a cylinder filled with oil, and this pressure transmitted by the oil to the recording and indicating gauges in the car above. The record of the amount of draw-bar pull is made on a continuous strip of paper 6 in. wide, which is drawn past the marking pen on the recorder at the rate or 13.2 in. per mile.

The paper is driven from the car axle as indicated and upon

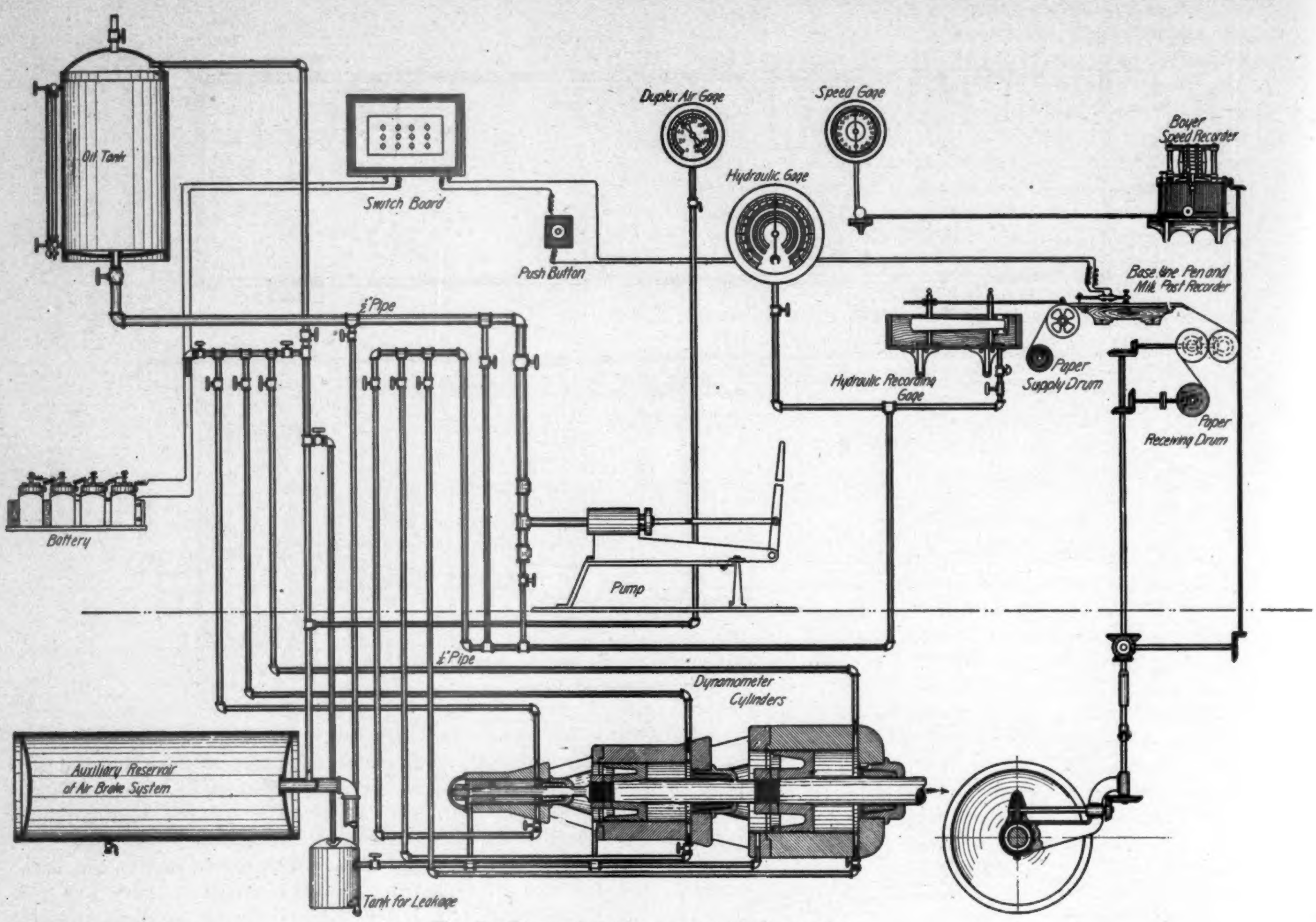


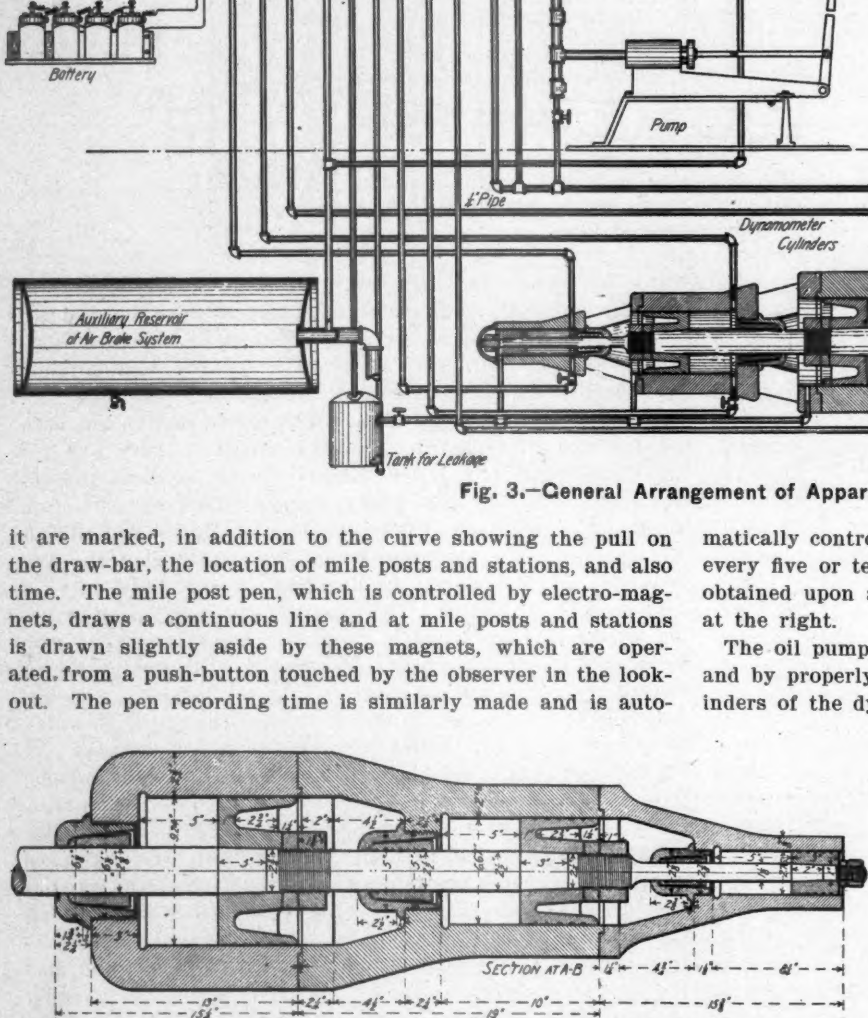
Fig. 3.—General Arrangement of Apparatus.

it are marked, in addition to the curve showing the pull on the draw-bar, the location of mile posts and stations, and also time. The mile post pen, which is controlled by electro-magnets, draws a continuous line and at mile posts and stations is drawn slightly aside by these magnets, which are operated from a push-button touched by the observer in the lookout. The pen recording time is similarly made and is automatically controlled by a clock which makes electric contacts every five or ten seconds as desired. A speed record is also obtained upon a separate chart in the speed recorder shown at the right.

The oil pump receives its supply from the oil supply tank, and by properly arranged piping forces it into the three cylinders of the dynamometer. Compressed air, taken from the auxiliary reservoir of the air-brake system, is used to clear the oil from the cylinders when necessary, and also to aid in filling them and to blow back from the leakage tank whatever oil leaks by the pistons and stuffing-boxes of the three cylinders.

From the switchboard electric connections are made to the various signals and pens, to the revolution counter in the car which shows the revolution of the driving wheels and also to the electric signals for indicator cards at the front end of the engine.

The dynamometer cylinders are shown in Fig. 4. They are made in three castings held together by stud bolts, not shown in the



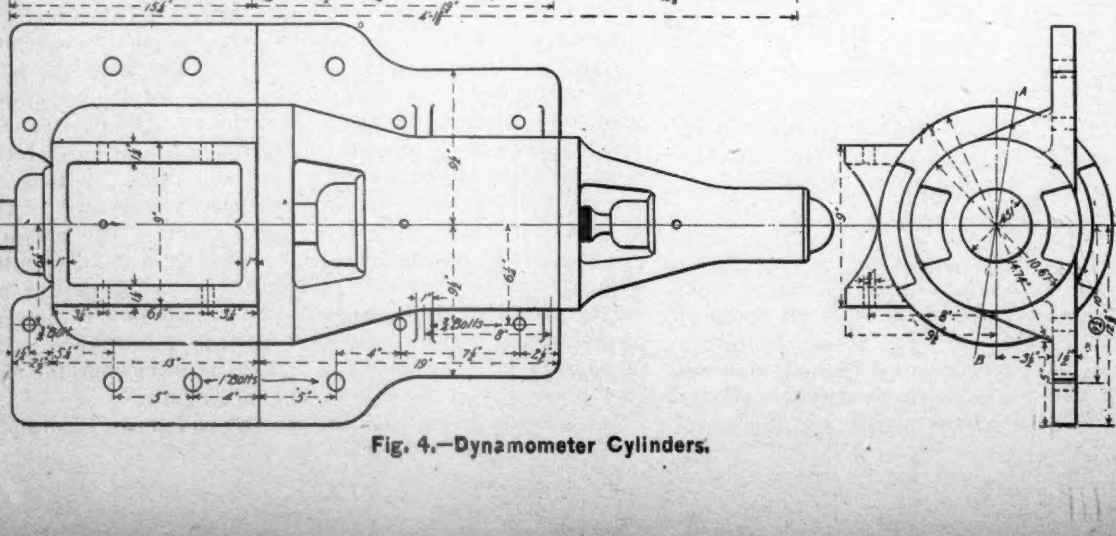
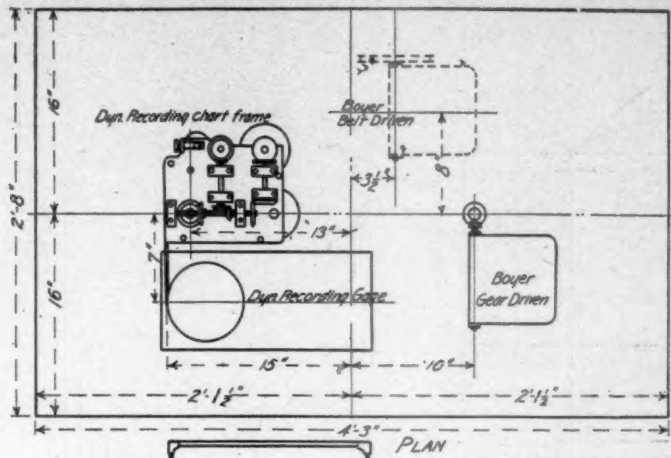


Fig. 4.—Dynamometer Cylinders.

drawing. The effective area of the largest cylinder is 60 sq. in., of the second 30 sq. in., and of the smallest 5 sq. in. It is intended that the working pressure of the oil in the cylinders is to be from 300 lbs. per square inch to 1,000 lbs. per square inch, and for this range of pressures cylinder No. 1 has sufficient capacity for the heaviest freight service, No. 2 will be used when working with a train of ordinary tonnage, while No. 3 will be used for passenger service. In this last case the working pressure may be somewhat higher. If it should become necessary, cylinders 1 and 2 could be coupled up in tandem, thus giving an effective piston area of 90 sq. in.



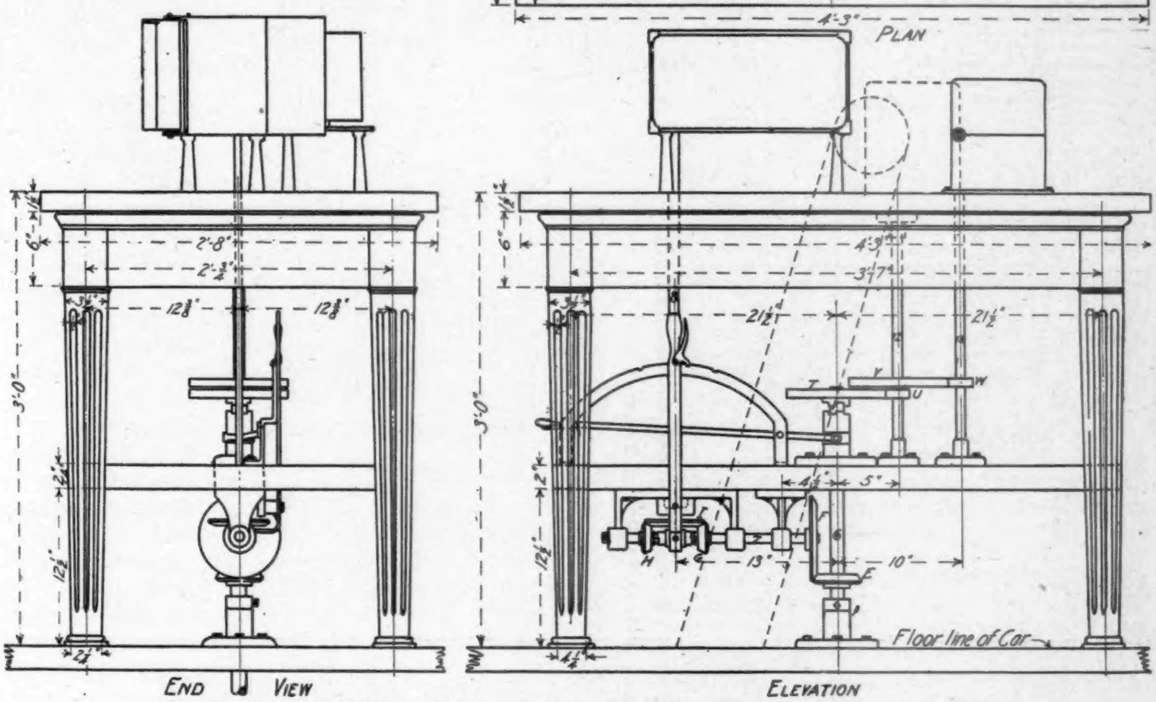


Fig. 5.—Table and Plan of Dynamometer, Recording Gauge and Speed Recorder.

The piston rod is connected to a draw-bar yoke of special design and is so arranged that when the piston travels forward too far beyond its working position the pull is taken on the springs of the ordinary draw-bar rig. Pushes on the rod are likewise received immediately upon these springs. An electric "tell-tale" arrangement notifies the operator when the piston passes its proper limits on account of the leakage of oil. The cylinders are reamed, the pistons ground and the piston rod ground where it moves through the stuffing-boxes. The stuffing-boxes were designed particularly for this arrangement and consist essentially of the inner sleeve or gland, which is ground internally to fit the rod and grooved as shown to retard the leakage. The forward end of the gland is ground spherical and fits into a ground spherical seat in the stuffing-box casting. This spherical seat is used to permit the three sleeves to align themselves properly on the rod. The pressure of the oil keeps the gland on its seat and the oil pressure is supplemented by the pressure of several helical springs placed between the rear end of the sleeve and the plate shown at the inner end of the stuffing-box. Considerable difficulty was experienced in making the joints between the cylinders and pistons and between the stuffing-boxes and rods sufficiently good to prevent undue leakage; but this has now been accomplished and the leakage under the upper limit of the working pressure, i.e., 1,000 or 1,200 lbs. per square inch, is not sufficient to in any way interfere with the proper working of the apparatus. The pistons will move forward on account of the leakage; but so slowly that the cylinders can be refilled from the pump at stops, or if necessary when the cylinders are under pressure. This design was resorted to in order to avoid the uncertainty concerning the frictional resistances incident upon the use of the usual packed pistons and stuffing-boxes.

The cylinders have been calibrated, in connection with their gauges, upon an Olsen testing machine, and the total pull on the rod necessary to overcome the friction in the apparatus found to be about 30 lbs. The cylinders are secured to the draught timbers by means of the flanges shown at the sides and top.

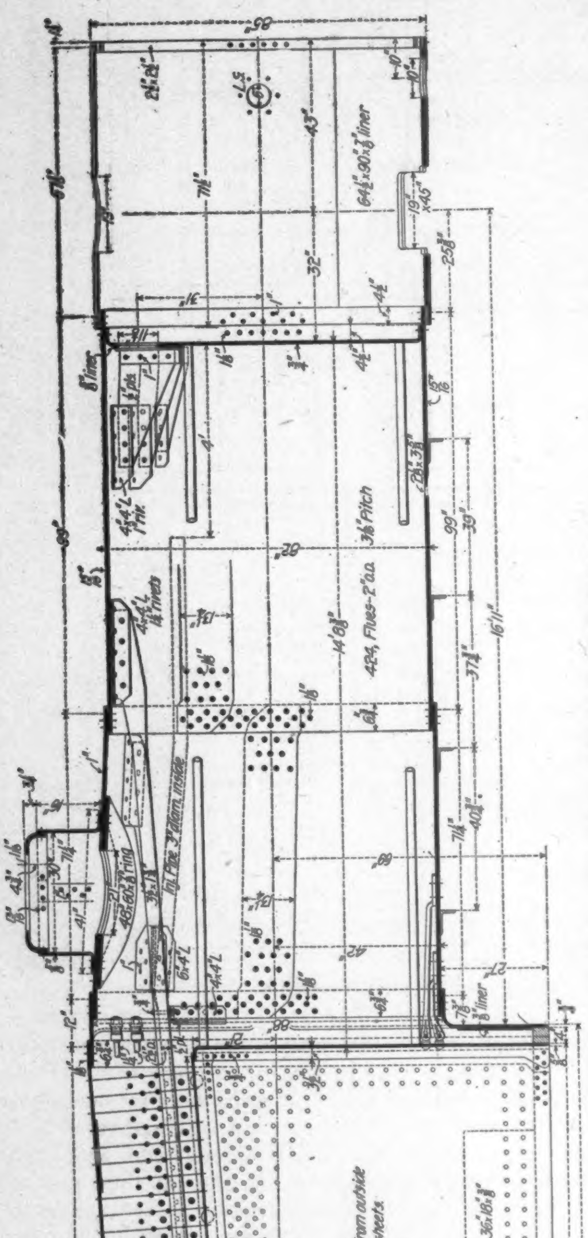
In Fig. 5 is shown the table upon which are placed the dynamometer recording gauge, the rolls for driving the paper chart, and the Boyer speed gauge. The vertical shaft projecting through the floor under the middle of the table derives its motion from the car axle by means of spiral gears and bevel gears. Its motion is transmitted, by means of the gears shown, to the speed gauge and to the paper driving apparatus. This last consists simply of a pair of driving rollers, around which the paper passes, and a supply roller and receiving roller. The paper is drawn from the former and fed to the latter after running over the drum of the recording gauge seen also at the left.

In addition to this apparatus the car is equipped, for locomotive road tests, with gauges for indicating and recording boiler pressure and steam-chest pressure, duplex air gauge, air brake train line pressure recording gauge, and the other apparatus used in locomotive tests. The track inspection apparatus and other apparatus are to be installed later.

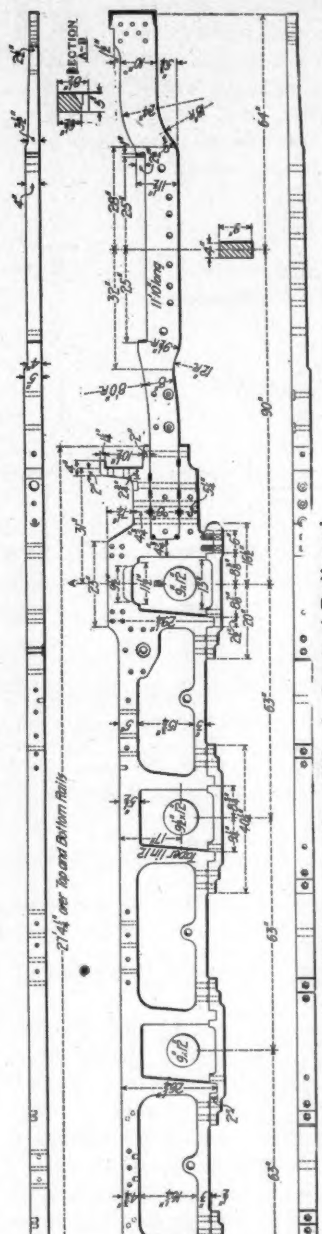
BOILER AND FRAMES—TWELVE-WHEEL FREIGHT LOCOMOTIVE.

Illinois Central R. R.

Built by the Brooks Locomotive Works.



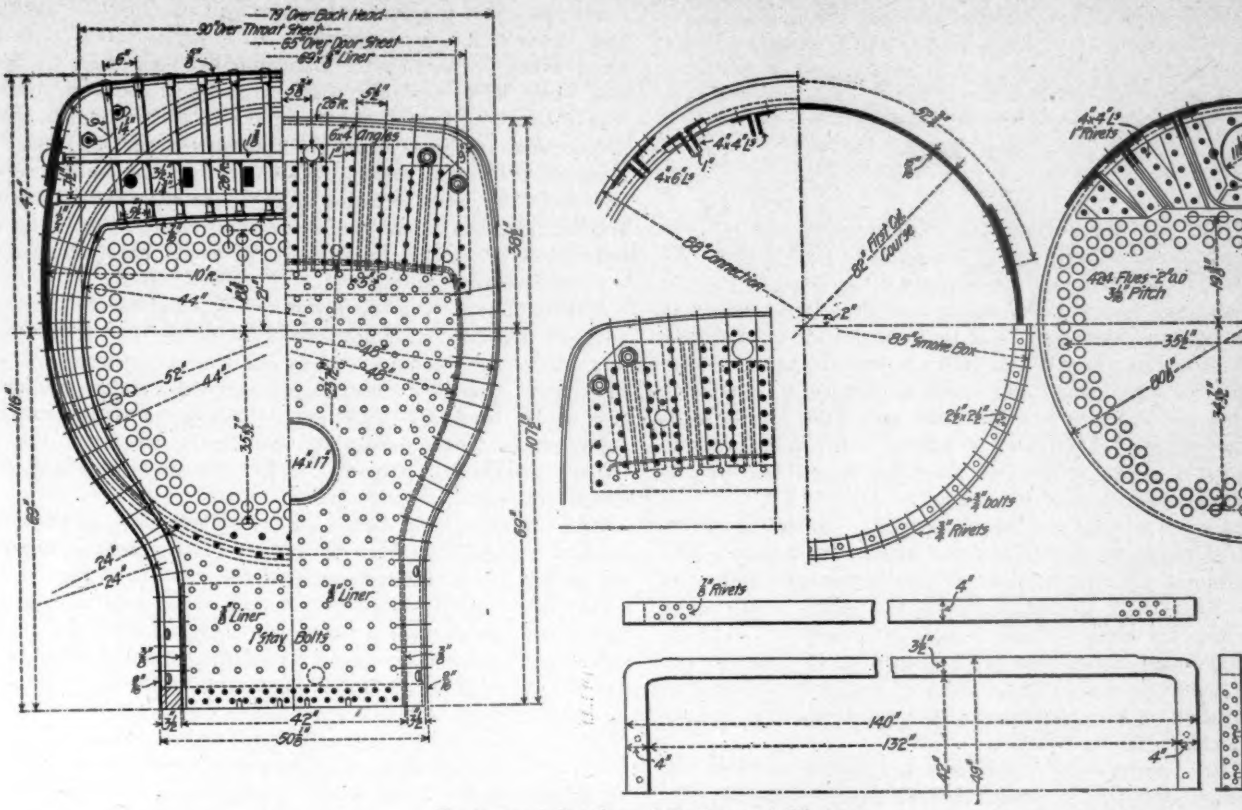
Twelve-Wheel Freight Locomotive—Illinois Central Railroad.
Longitudinal Section of Boiler.



Twelve-Wheel Freight Locomotive—Illinois Central Railroad.
Views of Frames Showing Single Bar Front Section.

The largest locomotive boiler ever built* seems worthy of illustration on account of its size if it was not otherwise interesting. The locomotive built for the Illinois Central by the Brooks Locomotive Works was illustrated in October, 1899, page 315, and we now show the boiler and frames. Attention has already been called to the high boiler pressure, 210 lbs., and the thickness of the sheets. The boiler is 82 inches in diameter at the front end and 85 inches over the smokebox. It is 90 inches wide at the firebox. The boiler is the "Player Improved Belpaire" type. The heating surface is 3,500 square feet and the grate area 37.5 square feet. The heating surface is large but it has been exceeded. The grate area is very large for a narrow firebox engine, the length being 11 feet. The boiler is very high above the rails, the center being 9 ft. 8 in. above the rail tops. This is the highest of which we have record, the Great Northern 12-wheel engines, at 9 ft. 5 in., being the highest previously built. This boiler is riveted with lap seams, a form which these builders appear to favor. There are 424 2-inch tubes, 14 ft. 8 in. long, placed at 3 1/16 inch pitch; the drawings clearly show the staying and bracing, the arrangement of the seams and other details to which special attention need not be called. This boiler was designed with a view of pulling a train weighing 2,045 tons, exclusive of engine, tender and caboose, up a 68-foot grade, combined with uncompensated curves of 3 degrees, at a speed of 15 miles per hour. To do this it will be necessary for the boiler to furnish steam enough to maintain a mean effective pressure of about 175 pounds.

*Since this article was written a much larger boiler, that of the Pittsburgh engine for the Pittsburgh, Bessemer & Lake Erie, has appeared. See American Engineer, July, 1900, page 214.



Transverse Section of Boiler and Firebox.

The frames are heavy and strong. The front end is the interesting feature. This form has been used by these builders for all engines with piston valves since the completion of the 12-wheel engines for the Great Northern (January 1898, page 3). The Great Northern engine had double bar frames, but since that time the single form has been used and with this bar of 4 by 9 inches section at the cylinders the construction is strong and stiff. It is probably better than the double frame of the Great Northern, and infinitely better than the ordinary single bar frame. In this design the center line of stress coincides approximately with the center line of the frame. This is important in heavy locomotives, and especially so in those with four-wheel trucks, giving a long distance between the cylinder and the splice and to the forward driving axle. In the double frame construction it is impossible to balance the stresses in the upper and lower members. The single bar frame in this case was not used to get out of the way of the piston valves, but the entire front end arrangements were planned to secure better construction, which should be strong and stiff.

It will be noticed that the front ends of the upper bars of the double portions of the frames are turned up to form knees for the attachment of the guide yokes. This is done on all piston valve engines with single bar front frames, and on slide valve engines with four-wheel trucks a similar bracket is forged upon the upper section of the forward rail. The guide yoke is lugged over the frame lugs and securely keyed against the frame in a manner similar to that with which the frames are keyed to the cylinders, thus forming a double lock. A double brace of hammered iron extends across the frames at the forward drivers. It carries the transverse equalizing spring, and the boiler brace is attached to it. A cast steel brace extends across the frames in front of the throat sheet and makes the expansion connection between the boiler and frames in front of the firebox.

The new torpedo boat "Viper" of the British Navy made a new speed record July 13 of 43 miles per hour. Our readers will remember that this boat is driven by Parsons steam turbines. The speed is remarkable, and is very close to that of long-distance railroad trains. Absence of vibration and small space per horse-power, with excellent steam economy, are the features which render the steam turbine specially desirable for such service.

The lease of the Fitchburg Railroad to the Boston & Maine has at last been accomplished. Changes will probably be made in the operating departments, but what will be done has not yet been announced. This move places the valuable terminal facilities on the north side of Boston under a single management, and it seems likely to result profitably to the stockholders of both roads, particularly if the prospective lease of the Boston & Albany to the New York Central is carried through. The necessary legislative action has been taken since the above was written, and the New York Central now reaches Boston.

The Wheeling & Lake Erie are planning extensive improvements in their shops at Ironville, a suburb of Toledo. The old paint shop will be replaced by a new building 100 by 300 ft., which will be used as an erecting shop, and the old erecting shop will be used as a paint shop. A new machine shop, blacksmith's shop and store room will be put up. The plans are being prepared by Mr. Charles Hazen, Master Car Builder, under the direction of Mr. Braden, Superintendent of Motive Power of the road. The shops will be equipped with new tools. At present the road is turning out eight new high-sided coal cars per day on an order for 1,200.

In many ways the "Daily Railway Age" at Saratoga this year is a worthy example among newspapers. It is a unique production in conception, purpose and conduct. For years the members of the Association have found it convenient and valuable as a prompt and extensive record of the proceedings of the conventions. It is more than a daily record of the discussions, for, until the appearance of the official volumes, it is the most complete account available, and to members who are prevented from attending it must be invaluable. Railroad men and supply men alike commended it especially this year and it is evident that the enterprise of the management is appreciated. This is indicated by the demand for the papers as they came from the press and by the unusual amount of advertising this year.

PROBLEMS THE WIDE FIREBOX SOLVES.

From the Fireman's Point of View.

By J. S. S. Fulton.

A study of how the demands of modern transportation and continued high speed with heavy trains have been met by the Motive Power Department shows very little departure from the old, and one may say the locomotive has simply grown in size to meet these demands. But that the firebox of the modern locomotive has reached the limits permissible under structural and operative conditions, must be conceded. Carefully considering the changes of conditions that time has brought about, and tracing the failures for steam with impartiality to find the direct cause, we perceive that the steam demand has grown beyond the limit of the firebox.

For the past several years I have kept a careful record of the failures for steam by the engines of the division to which I was assigned. For 78 per cent. of the failures the following causes are given by the engineer and fireman: "Poor coal," "fire getting too dirty," "had to stop to clean fire." These failures were reported on runs of an average of 150 miles, many of which made no stop. These failures are both undesirable and costly, and by an application of the proper natural remedy —grate surface—can be avoided.

The writer served eight years as a fireman on four of the largest railroad systems, including four years with the wide firebox in every class of service, from a switcher to the "flyers" on the Atlantic City R. R., with both anthracite and bituminous coal. And from the investigation and study which the ideal opportunity for comparison afforded me, I attained by practical experience and experiment a conviction of the merits of the wide firebox that cannot fail to assert themselves, when the awakening to this fact becomes complete, which a reference to the railroad journals tells us has begun. The prejudice of the railroad men to anything new or different from the old "rut," coupled with the lack of the proper instruction that usually fails to accompany any radical departure from the usual practice and the unhandiness that comes with anything different from what one has long been accustomed to, should caution every Superintendent of Motive Power to prepare for a "howl" when he introduces his first wide firebox. We all remember the introduction of the injector and the improved air brake. Neither can he expect the anticipated results for some time, unless he procures the services of some competent wide firebox fireman or engineer for a short time as instructor.

While I was firing an Atlantic type engine on the Atlantic City R. R., where a speed is attained and maintained that is not possible with the narrow firebox (not considering that the trains drawn consist of from 7 to 13 cars), a delegation of engineers and firemen from some Western road, who were East on a pleasure trip, came up to the engine as we were lying in the depot at Camden waiting for the leaving time for Atlantic City, 56.6 miles distant. After commenting humorously on the queer appearance these engines present to the beholder for the first time, one old gray-haired engineer remarked with emphasis, "I wouldn't run such a looking machine"; and several of the firemen seconded it by saying, "And I wouldn't fire one." But when we stopped in Atlantic City depot just 49 minutes and 40 seconds after we got the starting whistle, and while some of them had watched from the window in the door of the first coach with what little effort and work it was done, there were different kinds of expressions and a desire to know more of the wonderful machine. But the whole story was a short one—Grate Surface.

Returning to my engine failures. By investigating I found that nine times out of ten, good, and in most cases the best coal had been ordered and paid for; but in consequence of the short-sighted system of buying coal employed by most railroad companies the coal companies can practice the most unjust imposition. It is expensive to buy good coal; it is still more expensive to pay for good and get poor coal. A better way would be to buy poor coal and design fireboxes to burn it. I have seen and fired bituminous coal of so bad quality that it was known among the men as "asbestos sand," and yet have made all the steam required for the heavy fast freight service on the Philadelphia & Reading R. R. between Allentown and Harrisburg; and when the same fuel was put on a narrow firebox engine, as an experiment, we could barely "crawl" to the first coaling station.

A wide firebox will run about twice as far as a narrow one without cleaning; and does not require the fire to be "built up" and "burnt through" before starting as is necessary with the narrow type. Fire enough to cover the grates when spread just before leaving is sufficient. (This is no small saving to begin with.) These facts alone lead to the conclusion that the narrow firebox has already outlived its usefulness and is at best a make-shift out of date.

The lack of a good design that will bring the engineer and fireman together has been beyond doubt the greatest factor in preventing its adoption; although the "Prairie Type" goes a great way toward securing sufficient grate area and solving this. Any design that isolates the engineer from the fireman will never live as a standard. The death of the engineer without the knowledge of the fireman is not the only thing to be feared; sleep comes much oftener during the natural life of a man than death; and although I have never fired an Atlantic type engine with an engineer a corpse at the throttle, yet I have gone many miles, many times, with one asleep there, and my experience leads me to doubt if they are any better than corpses.

Although the best amount of grate area is perhaps undetermined, the writer conducted a series of experiments with bituminous coal on a 19 x 24-in. cylinder engine with a wide firebox of 76 sq. ft. grate surface and a 4¾-in. single exhaust nozzle. Thirty-six square feet of the front portion was bricked off by covering the grates with fire-brick; after each trip a row of brick was removed, and the exhaust nozzle enlarged until all the bricks were removed and the nozzle enlarged to 5 7/16 ins. with a decrease of fuel consumed each trip until 60 sq ft. were uncovered, after which no perceptible decrease could be noticed. There was a notable improvement in the smartness of the engine as the nozzle was enlarged and almost entire absence of smoke. Another test showed very little difference between the ratio of a poor grade of coal in a wide firebox and a good grade in a narrow one, proving that there is an avenue of waste in the narrow box, either from imperfect combustion or from the amount of fine coal that passes unconsumed through the flues, or both.

But there are still other problems the wide firebox solves. Good fuel cannot always be had, especially in mid-winter (when it is needed most) and when the demand for good grades is heavy and the price high. The extreme exertion required to fire the long narrow boxes that are designed on modern large locomotives has led to a serious agitation and on some roads an actual demand for two firemen on an engine. The wide firebox will stave this off for a long time to come, as the work is very much easier. Firemen on the Philadelphia & Reading R. R. say it is like taking a day off to fire one of the Wootten boilers after firing the narrow ones. The smoke nuisance is giving more and more trouble every day, and of all the smoke-burning devices and smokeless firemen I have yet met, none will approach the solution of this great problem nearer than a Wootten boiler properly fired.

As Mr. Edward Grafstrom's suggestion in the May issue of this magazine is open for criticism I venture to say that his proposed arrangement of ashpan over back drivers will burn out grates faster than they could be cast. The writer has had some experience along that same line. But if it were not for this objection it embraces more desirable features than any design yet produced.

COMPARISON OF HIGH-SPEED TRAINS.

A novel and interesting comparison of high-speed trains has been compiled by Mr. T. A. Lawes, Superintendent of Motive Power of the Chicago & Eastern Illinois Railroad, which is reproduced in the accompanying table. The Chicago, Rock Island & Pacific and the Chicago & Northwestern show the highest tonnage per square foot of grate and of heating surface. The Lehigh valley train, however, is probably hauled at fully as great advantage as the others in expense per ton mile. Such a comparison is new to us, and it is suggestive of the wide differences in locomotive practice in different parts of the country. The table is as follows:

COMPARATIVE HIGH SPEED TRAINS.

Name of R.R.	From–To.	Distance in miles.	No. of cars in train.	Weight of cars in tons.	No. station stops.	Miles run to one stop.	Schedule running time.	Average speed in miles per hour.	Style of engine.	Size of cylinder.	Diameter driving wheel.	Grate area, sq. ft.	Total sq. ft. heating surface.	Boiler pressure in lbs.	Tractive power at 85% of boiler pressure.	Ton miles per hour per sq. ft. of grate area.	Ton miles per hour per sq. ft. of heating surface.
							H. M.			In.	In.						
N. Y. C. & H. R.	New York Albany.	143	4	190	none.	......	2 40	53.7	8 Wh.	19 x 24	78	31.2	1,974.0	180	17,000	327.0	5.1
C. B. & Q.	Chicago Burlington.	206	4	200	2	103	3 52	53 3	Columbia.	18 x 26	84	31.8	1,599.5	200	17,045	335.2	6.6
B. & O.	Baltimore Washington.	40	7	240	none.	......	45	53.3	10 Wh.	2 x 26	78	34.3	2,155.1	190	23,740	372.9	5.9
Wabash	Tilton Granite City.	176.6	7	302	8	22	3 36	49.0	Atlantic.	19 x 26	73	29.8	2,423.2	200	21,860	496.2	6 1
Lehigh Valley	Buffalo Jersey City.	446.6	7	226.75	11	40.6	9 31	46.9	10 Wh.	19 x 26	70	63.9	2,200.0	180	20,510	166.4	4.83
C. & N. W.	Clinton Chicago.	138	9	470	6	23	3	46.0	8 Wh.	19½ x 26	68	30.4	2,504.2	190	23,495	711.1	8.63
C. R. I. & P.	Engewood Rock Island.	174	10	404	14	12.4	3 51	45.2	8 Wh.	19½ x 26	78	24.5	1,988.3	190	20,482	745.3	9.18
C. C. C. & St. L.	St. Louis Indianapolis.	273	8	340	9	30.3	6 5	44.8	8 Wh.	20 x 26	78	31.0	2,162.0	200	22,665	491.3	7.04
C. & E. I	Dolton Jct. Danville Jct.	106.5	5	190	8	13.3	2 25	44.1	8 Wh. 8 Wh. Mogul.	18 x 24 18 x 24 18 x 24	66 66 63	16.3 24.3 26.1	1,393.4 1,397.4 1,482.3	170 180 180	17,020 18,020 18,880	514.0 344.8 319.8	6.01 5.9 5.65
L. S. & M. S.	Chicago Buffalo.	535	8	335	14	38.2	12 53	41.8	10 Wh.	18 x 24	68	27.35	1,866.0	190	18,465	511.9	7.5
Atlantic Coast Line....	Richmond Charleston.	396	5	225	2	198	9 46	40.5	Atlantic.	19 x 24	72	26.1	2,047.2	180	18,410	345.3	4.4
Grand Trunk.	Port Huron Blue Isl'd Jct.	315.5	9	300	15	20	7 55	40.4	10 Wh.	20 x 26	72	33.3	2,001.0	200	24,550	363.9	46.05
Great Northern.........	Minneapolis Barnesville.	210	11	not given.	8	26.2	5 20	39.4	10 Wh.	19 x 26	73	24.6	1,797.0	180	19,670	....	....
M. C.	Detroit Kensington.	271	8	262	9	30.1	7 10	37.7	10 Wh.	19 x 24	62	28.5	1,703.8	160	19,000	346.5	5.79
Northern Pacific..........	Northtown J. Fargo.	229.2	8	330	6	38.2	6 15	37.2	10 Wh.	20 x 26	69	30.8	2,485.0	200	25,620	398.5	4.9
Ill. Central. ..	Fulton Memphis.	121	10	395	5	24.2	3 30	34.5	10 Wh.	19½ x 26	69	28.0	2,031.7	200	24,416	486.6	6.7

THE MODERN ROUNDHOUSE—WHAT IT OUGHT TO BE.

The business advantage of the maximum possible mileage of locomotives has been sought during the recent season of extraordinary traffic in order to make the most of the available power, and whether or not pooling of locomotives has been accepted as the best way of accomplishing this result, all are endeavoring to secure large mileage. An effect of this, which is probably to be permanent, is to show the weakness of present roundhouse practice. Roundhouse repairs become more important with the increase in size of engines, and the expense of running repairs aggregates "almost as much per 1,000 miles run as do the shop repairs." This fact and the necessity for "turning engines" quickly give to roundhouse work an importance which it never had before. Because of its thorough treatment of the subject and its suggestiveness, the attention of our readers is directed to the following recent report on the equipment and arrangement of roundhouses by Messrs. W. H. Marshall, George W. West and C. H. Potts to the Central Railway Club:

Modern locomotives have outgrown the dimensions of old houses and even recent houses are not, in all cases, made large enough to accommodate modern power. The up-to-date house should be at least 80 ft. between inside walls. As modern engines will approximate 65 ft. in length, this will leave only 15 ft. to be divided into spaces, which will permit workmen to pass around both ends of the engine, and to truck materials when necessary. The outer wall should be of brick with ample window area in it, and the inner wall should consist of cast-iron columns, spaced about 13 ft. centers with rectangular door openings and with plenty of glass in and above the doors. The rectangular doorway is better than the arched one, as it permits a hinge to be placed near the top of the door, which is of value in preventing the door from getting out of shape and racking to pieces.

The roof trusses should be of wood, as iron is corroded rapidly by gases present in the house. The best form is the common shed roof with a moderate slope, the greater height being on the inside walls.

The engines, when standing in the house, should face the outer wall; the chief reason being that there is more room and better light between engines at the machinery, where most of the work is required, than would be the case if the engines faced the table. To those that desire clean engines, there is an incidental advantage in that the engines, when starting out of the house, back on to the table, thus throwing less of the dirt from the stack over the engine.

The turntable should be a substantial affair, and a length of at least 70 ft. is to be preferred. It should be operated by electricity, if the current is obtainable at a reasonable cost. A compressed air engine is a good substitute when electricity is not available.

There is such a wide divergence of opinion regarding the roundhouse floors that we hesitate to indorse any one construction without qualification, but we believe that something better than a dirt floor is required for what might be called the work section of the house, where boiler washing and the heavier machinery jobs are done. Vitrified brick would appear well adapted to this section of the house. Whatever material is used for the floors, there should be planks suitable for jacking upon placed immediately outside of the rails.

All the steam, water and air pipes should be placed overhead, nothing going underground except the sewers. The main sewer should, if possible, be outside the outer walls and all pits, including the turntable, drained into it. The overhead pipes should include the water pipes for boiler washings and filling boilers, also an air pipe for kindling fires and a steam pipe for the blowers. There should also be placed overhead a pipe of not less than 4 in. in diameter, with suitable connections at

each stall, so that engines may be blown off in the house and the escaping steam discharged through this pipe. Such an arrangement will not only do much toward keeping the house free from steam in winter, but it will also prevent, to a large extent, the injury to boiler jackets due to drippings from the underside of the roof. Furthermore, the constant presence of steam throughout the house causes a rapid deterioration of the house itself.

The house should be lighted with electricity, if it is available. Economy demands better light than we find in most roundhouses. The turntable and the coal chutes should also be lighted by electricity.

The customary method of heating roundhouses is to use live or exhaust steam, circulating in pipes placed on the two side walls of each pit. The ventilation is supposed to be accomplished by ventilators of various kinds, placed on the roofs. While some of these utilize the outside air currents to draw the foul air and gases out of the house, they must all depend upon natural draft when the outside atmosphere is quiet. At such times the ventilation is practically nil. We believe that the hot blast system of heating is not only an improvement over the heating apparatus now commonly used, but will solve the entire question of ventilation in winter. With a large volume of warm air being forced into the house, the gases and steam will be driven out of the ventilators. Thus it is possible to have a roundhouse that, with windows and doors closed, is nevertheless a comfortable place to work in. In summer the open doors and windows take care of the ventilation. In using the hot blast system the air should be delivered through ducts which terminate in the side walls of each pit, thus delivering the air where it will be most effective in thawing out engines that have come into the house covered with snow and ice.

The general equipment of a roundhouse should comprise such machinery, small tools and stock of supplies as will permit all running repairs to be made with dispatch; the line should be rigidly drawn, however, between roundhouse repairs and work that properly belongs to the shop, and the roundhouse forces should not be allowed to undertake extensive repairs upon an engine, except in rare emergencies. There is a disposition on the part of some roundhouse foreman to keep at least one engine under repairs at the roundhouse, so that when the regular work becomes light the men can be switched onto this job; it invariably results in holding the engine undergoing the repairs many times as long as would be required if the work had been done in the shop, and furthermore the expense of such repairs will be higher than it should be. But while thus excluding the shop work from the roundhouse, we believe there should be a sufficient equipment of tools at every large roundhouse, so that the running repairs can be handled quickly. Such tools as are installed should be first-class in every respect and should not be old-fashioned, worn-out tools discarded by the shops. Modern tools should be provided even if it is necessary to purchase new ones in order to accomplish it.

The equipment should consist of not less than one 14-in. lathe, one 26-in. lathe (or larger), one 30-in. drill press, one bench drill, one 1½-in. single-headed bolt cutter and one 26-in. shaper (planer movement), and one 30 by 30-in. planer. These tools, if supplemented with a suitable outfit of jacks, small tools, etc., will give a roundhouse force every facility needed for doing work promptly. Drop pits should be provided, and in the large houses it is better to have one pit for driving wheels and another for truck wheels, the latter pit being constructed so that the wheels can be transferred laterally and brought up to the floor between the tracks. For boiler washing purposes, we believe in supplying a duplex pump of ample capacity, capable of supplying a pressure of not less than 120 lbs.

We believe that it should be the aim of every large roundhouse to perform the heavier work on engines on pits in close proximity to the machine shop. On these same pits the work of boiler washing should be done, as, at that time, it is usually practicable to do considerable other work on the engine. In fact if the roundhouse work is handled properly, the washing out of engines need not be such a bugbear as it often is. If an engine, in arriving at a house, requires repairs that would take six, eight or ten hours, the boiler can be washed out at the same time, even though it is not the regular wash-out day for that engine. Then, when the engine goes out it will run longer before being again subjected to the delay incident to the washing out. If roundhouse work is to be handled in this manner, the work section and the washing-out section of the house should coincide, and that portion of the house, as already stated, should be near the machine shop, and in it should be located the drop pits and other facilities for doing heavy work.

If it appears to some that the roundhouse facilities recommended in this report are more elaborate and complete than are provided in modern practice, we would call attention to the fact that engines are getting larger and that the strain to which the various parts are subjected is much greater than in engines built a few years ago. If large engines are to make good mileage between shoppings, they must have excellent care in the roundhouse. Many minor repairs in the smaller engines that could be safely permitted to go for a trip or two, until there was time and opportunity to do the work, must be taken care of at once on the larger engines in order to avoid failures on the road and damage to the engine. Furthermore, engines of all sizes are compelled to work harder to-day than they ever did before, and the hard work locates all weak spots and exposes poor roundhouse work in a manner that is mortifying to the mechanical department and expensive to the company.

A LOCOMOTIVE BUILDER'S OPINIONS OF THE TWO-CYLINDER COMPOUND LOCOMOTIVE.

With special reference to the two-cylinder compound, Mr. J. E. Sague of the Schenectady Locomotive Works expressed opinions before the convention of the Master Mechanics' Association as follows:

In regard to the attitude of the builders of compound locomotives, I can speak to some extent for the Schenectady Locomotive Works and say that we favor the compound engine very thoroughly. We have had very flattering reports from most of the compounds we have built during the last six or seven years. We consider the compound engine entirely out of the experimental stage. We expect, however, to improve the details from day to day, and think that in ten years from now our compound engine may be materially different from what it is to-day.

Some of the objections raised to compound locomotives at the beginning of their use in this country are interesting reading now. It was objected to the two-cylinder compound that the low pressure cylinder would be unduly large for heavy locomotives; as a matter of fact, no cases have arisen in our experience in which the large size of the low-pressure cylinder was a governing factor. The limiting clearances in the case of heavy two-cylinder compounds are generally the clearance of the cab and the clearance from the track of the main crank pin, the same as for simple engines.

We do not urge the compound engine in season and out of season. We believe it is a subject in which the mechanical men should have the decision. I think the hesitancy in using the compound locomotive on some roads is due to the fact that they think compounds are in a state of development, and that by waiting two or three years they may get a better compound engine than now. I should hardly think that that attitude is a good one because for heavy freight service, at least, the compound engine is surely sufficiently better than the simple engine at this date.

There seems to have been a tendency to decry two-cylinder compounds to some extent for passenger service. I believe that the two-cylinder compound engine is thoroughly well adapted to passenger service, and in some cases will effect as much saving in passenger service as in freight service. There is, however, not generally the same chance to effect saving in passenger service as in freight service, as the simple passenger locomotive operates usually at a better rate of expansion than the freight locomotive and, therefore, is more economical. There is, for this reason, not the same opportunity for saving by compounding. This applies to all types of compound locomotives. In one case trials were made of two locomotives, one simple and one compound, for passenger service. The indications were that the compound engine

was better for certain heavy divisions where the grades were long, and the simple was, if anything, better on some undulating divisions. The result was that we got an order for duplicate engines, part simple and part compound, but before the order was executed we were asked by the officials of the road if they could not change the entire order to compound locomotives.

One feature in which the compound locomotive compares unfavorably with the simple locomotive in passenger service is the weight of reciprocating parts, and this has not been touched upon in this discussion. It is an impossibility to make reciprocating parts as light in compound locomotives as in simple locomotives. We have urged for years before this association that reciprocating parts should be reduced to the minimum, and a number of builders have done all they could, and strained a point perhaps, to make the pistons, piston rods and crossheads light, for the purpose of diminishing the reciprocating counterbalance on the track, and this has been lost sight of somewhat in compound locomotives for passenger service. We think it would be well to state in locomotive specifications that the dynamic effect upon the track must not exceed a certain amount, say 25,000 pounds for each driving wheel at 60 miles an hour. In order to meet such a condition we would have to consider carefully the weight of the reciprocating parts. We are now generally called upon to balance the locomotive so that it will ride easily, and I have only known two cases in which the railway has analyzed the effect of the reciprocating parts upon the track.

Another point occurs to me in regard to the statement in this discussion, that the compound locomotive occupies an unfortunate position when in use among a number of simple locomotives. My experience has been different from this. We recently built a compound locomotive for service among a lot of 18 simple locomotives. The pooling system was used and the results of the compound locomotive were so favorable that the men tried to get the compound engine in preference to the simple engine.

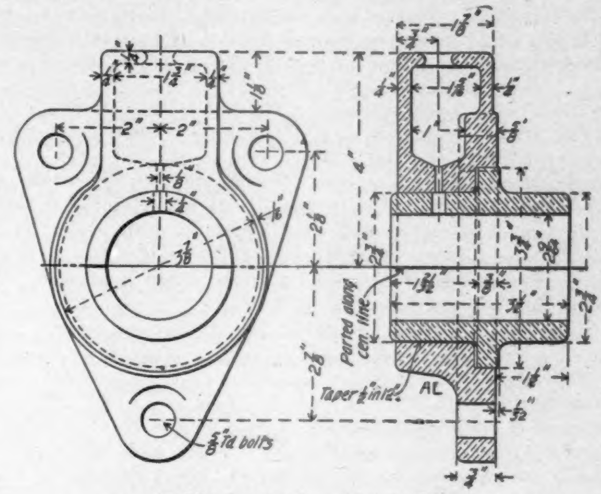
End doors in passenger cars for suburban and elevated railroad service seem to have decided advantages over side doors for rapidly delivering and taking on passengers. This will surprise those who have not given the subject careful thought, because it seems at first almost self-evident that the greater the number of entrances the quicker the loading. The "Railroad Gazette" investigated this subject in 1894, and in a recent issue presents interesting figures comparing the two systems. The average length of stop on the Manhattan Elevated with end doors only is put at 12 to 15 seconds, while that of the London Underground is 30 seconds with side doors at each compartment. Mr. R. H. Soule, when in South Africa, a short time ago, noted the average length of stops on the local trains of the Cape Government Railway to be 22 seconds with side doors, which he afterward compared with almost exactly similar suburban service on the Illinois Central in Chicago, where the average stop was 11.5 seconds. The latter service had end doors. The reasons given for the better results with the American cars with end doors are the assembling of passengers at the ends of cars before reaching a station and the possibility of taking on a group of passengers from a platform without the delay occasioned by a selection of seats or compartments before the train starts. In our cars the seating may be done after the train starts, whereas in the side-door system a passenger may detain the entire train while he picks out a seat to his liking. The side doors must be closed by the train men, which causes additional delay.

Dr. Winthrop E. Stone has been chosen President of Purdue University, to succeed the late Dr. James H. Smart. Dr. Stone has been Vice-President of the University for several years.

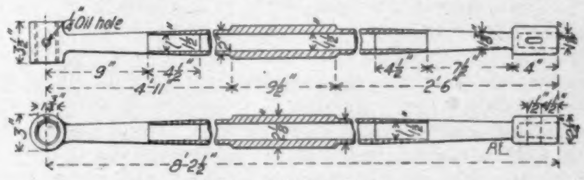
HOLLOW VALVE STEM AND GUIDE.

Richmond Locomotive Works.

A neat design of hollow valve steam, as made by the Richmond Locomotive Works, is shown in the accompanying engraving, and we also show a drawing of the guide in which the enlarged portion of the valve stem works. This valve stem is made of 2-inch hydraulic pipe into which the solid ends are welded. The pipe is upset for a distance of 9½ inches at the center in order to avoid weakening by wear. As the length is over 8 feet in this instance, and often as great as



Guide for Hollow Valve Rod.



Hollow Valve Rod.
Richmond Locomotive Works.

9 feet 6 inches, it is desirable to furnish a guide, which, in this case, is in the form of a bushing made in halves and tapered so that it may be drawn up easily to suit the valve stem. To take up lost motion, due to wear, the edges of the split bushing are pared off and it is drawn in closer than before, so as to close to the correct position for the stem. These hollow valve stems are in use upon a number of 10-wheel engines on the Southern Railway and also on passenger engines of the same type where unusual length was involved, on the Plant system and the R. F. & P. R. R.

In speaking of improvements in the compound locomotive, Mr. W. S. Morris of the Chesapeake & Ohio recently said: "The intercepting valve we are using is of the same design as that used eight years ago, and we have not yet found room or reason for improvement. The one referred to is working to-day as well as when it was first applied, and has not cost a cent for repairs. In the slide valve and steam distribution considerable improvement has been made. In this connection I refer to the application of the Allen valve, having the auxiliary port so arranged in relation to the steam ports in the valve face of the cylinder, that it serves as an exhaust port in the early part of the exhaust period, thus relieving the back pressure in the cylinder to a considerable extent, especially at high speed. By special investigation we have found with an engine on which the double-ported valve was put in the place of the old plain valve a speed of 26 to 39 miles per hour indicated a gain of 18 to 41 per cent. in power comparatively, and would undoubtedly have continued at that rate still higher if we had cards from the plain valve for comparison at higher speed."

CORRESPONDENCE.

CAST STEEL DRIVING WHEELS.

To the Editor:

Some time ago (February, page 43, and March, page 90, 1900) you published in the American Engineer two articles on cast steel wheel centers illustrated by examples of the latest practice. As I have been trying to get permission from some of the railway officials to make our centers with rims cut in four places, I had the gist of your articles translated into Russian, and also a sheet of drawings made representing your cuts as an argument in favor of my proposition. As it may interest you to see what your article looks like when done into Russian, I herewith enclose a copy of it and one of the sheets of drawings.

W. F. Dixon,
Chief Engineer Sormovo Works.

Nijni Novgorod, Russia, June 17, 1900.

[This cutting of rims of cast steel driving wheels brings out differences of opinion. Mr. Prince, of the Philadelphia & Reading, leaves them solid and uses elastic moulds. Mr. F. W. Webb, of the London & Northwestern, does not find it necessary to cut them. In neither of these cases has there been any trouble.—Editor.]

TRAIN LIGHTING FROM THE CAR AXLE.

To the Editor:

In view of the two appalling railway accidents that recently occurred almost simultaneously in Georgia and Wisconsin, in which a large number of passengers were burned to death through the conflagration and explosion caused by the use of oil lamps in the cars, I deem it not inappropriate, through the medium of your valuable paper, to call the attention of railway officials to the system of electric train lighting from the car axle, the use of which on passenger cars absolutely prevents the possibility of conflagration or explosion in case of a railway accident or wreck. This system, which is known as the "Axle Light" system, is in use on several of the leading railway lines and is already growing in favor and in use because of its superiority over all the old methods of car lighting, its safety in case of railway accidents being only one of its many attractions for the American travelling public.

JOHN N. ABBOTT,
Vice-President and General Manager,
Consolidated Railway Electric Lighting & Equipment Co.,
100 Broadway, N. Y.

WANTED—A GOOD RAILROAD.

To the Editor:

I have read your article, "What Motive Power Officers are Thinking About," in the March number of the American Engineer. The entire article is readable and to the point, but I am most directly interested by the statement that "subordinates should be selected with a view of the possibilities of advancement." This seems quite reasonable, and I certainly will not attempt to contravert it, as the principle involved should operate to my advantage.

I am a stenographer, 26 years of age; I have had two years' experience in the motive power department of a railway, in addition to a previous experience of five years in connection with correspondence in general office work, and a college education. During the two years I have been engaged in railway work I have obtained a pretty thorough insight into the office routine and correspondence of a motive power department and have, so far as I can say, given entire satisfaction to my employers. For my services I have received a small salary and the above-mentioned experience, the value of which I will not deny. However it has struck me forcibly that the officials of the road by which I am employed do not trouble themselves greatly with the "advancement of subordinates," and I would be thankful for any information leading to the discovery of a railway whose officials devote more thought to this subject. You might be able to help me in this respect, or possibly you may consider my letter worthy of publication as an indication of the interest with which your articles are read. If so I shall certainly deem it a favor.

I presume your article has more particular reference to employes possessing technical knowledge in connection with motive power department matters, but I think you will agree that the proper handling of office work and correspondence is of perhaps greater importance than has heretofore been admitted, and should therefore receive more attention than has been devoted to it. Possibly you may consider this suggestion as worthy of attention, and devote more space to this class of work in your valuable publication in future. In the meantime if you are able to direct me to such a railway as I have mentioned above I shall be grateful. "Reader."

[Comments upon this letter will be found on the editorial page of this issue.—Editor.]

DIRECT CURRENT MOTORS FOR VARIABLE SPEEDS.

To the Editor:

In looking through your July issue, we find a quotation from the paper read by Prof. W. S. Aldrich, at the Mechanical Engineers' Convention, as follows:

"The induction machine as it stands to-day is probably the most perfect motor yet developed from the standpoint of electric transmission in factories and mills. It may be started and operated from any point at any time at practically any load and speed within its predetermined ranges. It will permit of higher lineal speeds than are possible with any other type and cannot be burned out from rough usage and overloads. This makes the induction motor especially fitted for driving almost all classes of shop machinery."

It is our opinion that Prof. Aldrich became unduly enthusiastic over the induction motor when he wrote those lines, for the reason that the facts do not bear out the assertion. The statement that "the motor cannot be burned out" is too strong. It might be true in a machine designed with that point alone in view, but in the commercial machine there are limiting conditions. For instance, a Westinghouse No. 4 crane induction type motor, running normally at 825 revolutions with 200 volts, may be run for one hour at 720 revolutions; at 670 revolutions for 15 minutes; at 620 revolutions for 2½ minutes; at 500 revolutions for 1 minute, and at the end of the time limits given the secondary has reached a limiting temperature.

As to the statement that "the induction motor can be started from a distance." This is true of but one make of these motors, and while some conditions may demand that a motor be started from a distant point, it would eliminate the advantages of competition to specify this feature. We doubt if any business man would consider it good policy to place such limitations upon his affairs. Regarding variable speed for induction motor service, we doubt its practicability, and one of the best assurances that our position is well taken comes to us in the July 7th issue of the "Electrical World and Engineer." On page 34 of that issue will be found a description of the new works of the Westinghouse plant at Havre, France. It states that "the big crane will be operated by the 500-volt direct current," although constant speed induction motors are used to operate shafting. If variable speed induction motors are thoroughly practical and desirable, why have they not been installed upon this crane? After an experience of several years with the induction motor on their crane at East Pittsburg, the judgment of the manufacturers in selecting the direct-current motors for crane service practically proves that the induction motor is not desirable where variable speeds are necessary.

In further support of our position, permit us to quote from the report of the committee appointed by the American Railway Master Mechanics' Association, of which Mr. Geo. Gibbs, a man of wide practical experience and who is intimately associated with the manufacture of the induction motor, was chairman. This report says: "For alternating motors the same considerations as for the 'direct' apply, but variable speed running in this type for tool driving motors is not practicable." "The disadvantages of the alternating-current motor are its high speed and the fact that it is essentially a constant speed machine."

After a consideration of the above facts, do you really think that the statement made by Prof. Aldrich that "induction motors are specially fitted for driving almost all classes of shop machinery" is true?

We certainly do not think so, and when we further consider the statement made by the committee above quoted, that "it is the belief of your committee that one of the great advan-

tages of electric driving is in the possibility of simple speed regulation," we are not giving undue praise to the direct-current machine when we say that it is the only practicable motor for direct connection to machine tools or other machinery requiring a variable speed.

In connection with this subject, it is also interesting to note what this same committee says regarding the selection of a system. We quote as follows: "For long distance transmission, say one mile or more, alternating transmission is almost a necessity; for shorter distances, and in cases of isolated plants in compactly grouped railway shops, the direct-current system can be employed without any practicable disadvantages in waste of power in transmission line."

This same conclusion has been arrived at by Mr. Alexander Seimens, who, in the discussion of the paper on the subject of electric transmission before the Institution of Civil Engineers, said:

"The advocate of any one system desires to see that system adopted everywhere and deprecates any competing scheme. Such a controversy is now taking place between the three-phase system and the direct-current system; but they both have their good points. To my mind the alternating currents have the great advantage that the currents can be generated at a low voltage, transmitted at a high voltage, making it possible to use thin conductors, and then used at the motors at a low voltage, a transformation taking place at each end of the line. The great drawbacks of the three-phase induction motors are that they give their best efficiency at one particular speed, and if they are slightly overworked they stop. I have invariably found that for any small distance like 200 to 1,500 yards, a direct-current plant is cheaper than the three-phase plant; but for larger distances, the calculation comes out differently. The great ease with which the direct-current motors can be regulated and run at different speeds, together with their corresponding good efficiencies, induce me to be a strong advocate of direct-current motors. Another reason why I advocate these machines is that the three-phase currents for lighting are not so simple as the direct-current, as the current has always to be kept exactly equal in the three branches, or there will be a disturbance."

These remarks, coming from so eminent a gentleman as Mr. Seimens, and the remarks quoted from the report of the very able committee appointed by the American Railway Master Mechanics' Association, should have great weight with intending purchasers of electric machinery for power and lighting.

Bullock Electric Manufacturing Company,
Frank G. Bolles, Manager Advance Department.

THE FERRELL WOOD FIREPROOFING PROCESS.

By invitation of the New York Shipbuilding Company a large and distinguished party of representative business men from New York, Philadelphia, Boston and other large cities, gathered at their yards in Camden, N. J., recently, to witness an extremely interesting and practical test of the merits of wood, fireproofed by the Ferrell process, owned by the United States Fireproof Wood Company.

For the purpose of the test two small buildings, 6 ft. square and 12 ft. high, had been erected, each built identically the same, except that one was built of ordinary wood and the other of fireproof wood; the outside was built of white pine, the inside of poplar, with cherry and ash casings, the floors of Georgia pine and the roof of cypress shingles.

The houses were supported at the corners and raised 2 ft. above ground, with a large chimney in the center of the roof and rising 4 ft. above it; the lower portion below the floor being built of ash and open lattice work, leaving it perfectly free to the passage of air. Under each house and against the sides were piled shavings, cotton waste and wood saturated with oil, and at a given signal both houses were fired. In a few minutes the house built of ordinary wood was on fire, the flames spreading rapidly, and in 16 minutes it fell to the ground in ruins.

On the other house the effect was remarkable; the flames from the fuel had died out, leaving no traces whatever, except a thin charred and blackened surface where they had come in direct contact with it—just as would have been done to asbestos under the same conditions—but the house remained structurally intact and uninjured. More wood soaked with oil was then piled inside the house, the heat being so intense as to crack and melt the glass; this was done again and again, but with a similar result; it was impossible to set it on fire.

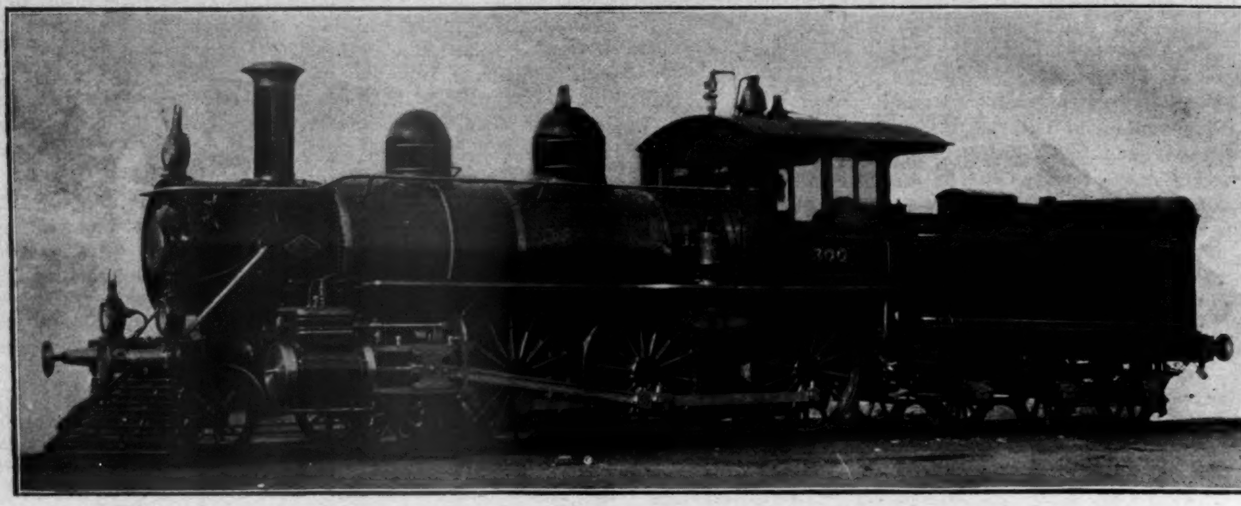
In addition to this test two other houses, 5 ft. square and 8 ft. high, had been built, one of fireproof wood and another of ordinary wood, with live electric wires coiled around and through from floor to roof; the current was turned on, but no effect was noticeable on the fireproof wood save the blacking of it by the glowing wires at the points of contact, while the ordinary wood was in flames in six seconds, the tests terminating by the melting of the wires. Tests were also made with the Bunsen blast burner and a flame of 3,000 degrees Fahrenheit projected against the treated wood, a flame powerful enough to melt iron or copper, but the wood merely charred and glowed where the flame was directly applied, the part surrounding it remaining cool and unaffected by the intense heat.

An exhibition was also given showing samples of the treated wood of all kinds, oiled and varnished, which showed that the treated wood could more readily take and hold the oil and varnish than the untreated. Pictures of the demonstrating and testing plant, which is located at 2218-20 Race Street, Philadelphia, where the process can be seen in actual operation, were also shown and the process explained.

The demonstration was not merely to show that wood could be made fireproof, for that has been done before, but to show that the Ferrell process can, in a short time, heart-treat thoroughly all kinds and sizes of wood, whether green or dry, in its natural state, just as it comes from the lumber yard; and without any previous boiling or drawing out of the natural juices; and that, at a cost so very little higher than the untreated wood that it can be used commercially for all purposes, and not be confined to the higher grades of woodwork as it has been heretofore; in fact the wood can be treated quicker and cheaper than by other processes. The chemical solution used in the fireproofing is non-volatile, thus insuring the permanency of the treatment; it is also non-hygroscopic and non-corrosive. It is forced in under heavy hydraulic pressure, mechanically controlled, without in any way injuring the fibrous tissues or changing its color or natural qualities. The treatment in every way tends to preserve and improve the wood, making it take paint, oil and varnish better, besides being as easy to work with tools as the untreated wood.

The right to use the patent in New York and adjacent territory has recently beeen purchased by the New York Fireproof Wood Company, and they have now in course of erection at Long Island City a plant covering three acres of ground and capable of treating 15,000,000 ft. of lumber annually. By direction of President Henry G. Morse the tests were conducted by Captain Wm. G. Randle, Treasurer of the New York Shipbuilding Company, and the results were in every respect satisfactory.

The causes of flange wear of car wheels has been studied and discussed at considerable length before the St. Louis Railway Club and one of the most important contributions was made recently by Mr. P. H. Griffin, President of the New York Car Wheel Works, in connection with the differences in diameter of wheels on the same axle. If one wheel is larger than the other the larger one will advance ahead of the smaller one as far as the flanges will permit and both wheels will then revolve with the flanges crowding against the rails. It is evident that this will cause flange wear and that it becomes worse with increasing speeds and loads. Mr. Griffin refers to the well-known fact that wheels of different diameters are frequently found under new cars. In spite of the greater care which is now exercised in taping and gaging wheels, there is room for improvement in this direction. Mr. Griffin believes that the average difference in diameter of cast wheels is now about ⅛ inch and considers present practice in fitting wheels as far from what it ought to be. Flange wear is known to increase the resistance of trains and this, in addition to the incidental wear and tear of the track and equipment, constitute good reasons for taking this question with vigor. It is increasingly important as speeds become higher and loads become heavier.



TEN-WHEEL SIMPLE PASSENGER LOCOMOTIVE.

FINLAND STATE RAILWAYS. RICHMOND LOCOMOTIVE WORKS, *Builders.*

Weights: Total of engine............90,000 lbs.; on drivers ....65,000 lbs.; total engine and tender............117,000 lbs.
Wheel base: Driving............12 ft. 6 in.; total engine and tender........ 39 ft. 11¼ in.
Cylinders: 16x24 in. Wheels: Driving............62 in.: truck..... ... 33⅜ in.; tender .... 37 in.
Boiler; Radial stay, straight top ... .52 in. diameter; pressure..... ......180 lbs.
Firebox: Length....56¾ in. width....37 in.; depth, front....68¼ in.; back....67 in.; grate area 15.2 sq. ft. Tubes, 170 2-in...12 ft. 7⅝ in. lorg.
Heating surface: Tubes............1,114 sq. ft; firebox...... ....80 sq. ft.; total...........1,194 sq. ft.
Tender.......... six-wheel. Tank capacity.......... 2,100 gals. water, 5 tons coal.

TEN-WHEEL PASSENGER LOCOMOTIVES.

Finland State Railways.

Built by the Richmond Locomotive Works.

The locomotive shown in this engraving is one of ten just completed for the Finland State Railways by the Richmond Locomotive and Machine Works. Nine of them have been shipped direct to Helsingfors, Finland, and the tenth has been sent to the Paris Exposition. These engines are not heavy or large in comparison with recent practice here; they have copper fireboxes, copper staybolts and brass boiler tubes. The tender is carried on six wheels, the first pair being in pedestals and the other two pairs in a four-wheel swiveling truck. The cab is of steel. The air brakes are of the Westinghouse "European" pattern with the driver brake shoes in front of the wheels. The design, except as noted with regard to boiler materials and a few other details, is similar to usual American practice. The valves are the "American balance," by the American Balance Slide Valve Company, Jersey Shore, Pa. The engines are lighted by Pintsch gas. The following are the chief characteristics:

General Dimensions.

Gauge	5 ft. 0 in.
Fuel	Coal
Weight on drivers	65,000 lbs.
Weight in working order	90,000 lbs.
Wheel base, driving	12 ft. 6 in.
Wheel base, total engine and tender	39 ft. 11¼ in.
Total length of engine and tender	50 ft. 9½ in.

Cylinders.

Diameter	16 in.
Piston stroke	24 in.
Piston packing	Cast iron
Piston rod, 2¾ in.	Steel
Piston rod packing	U. S. Metallic
Steam ports	1¼ in. by 15 in.
Exhaust ports	2½ in. by 15 in.
Bridge width	1 in.

Slide Valves.

Style	American balanced
Greatest travel	5¼ in.
Lap, outside	⅞ in.
Lap, inside	0 in.
Lead in full gear	1/32 in.
Valve stem packing	U. S. Metallic

Wheels.

Driving, number	6
Driving, diameter	62 in.
Driving centers	Cast steel
Driving boxes	Cast steel
Driving axle journal	6½ in. by 8 in.
Engine truck, style	Center bearing, swing motion
Engine truck wheels, diameter	33⅞ in.
Engine truck wheel centers	Wrought iron
Engine truck axle	Steel
Engine truck journals	4½ in. by 7½ in.

Boiler.

Type	Straight top, radial stayed
Working pressure	180 lbs.
Outside diameter, first course	52 in.
Thickness of plates in barrel	½ in.
Thickness of plates, roof and sides	½ in.
Seams, circumferential	Double riveted
Seams, horizontal	Butt sextuple riveted
Firebox, length	56¾ in.
Firebox, width	37 in.
Firebox, depth	Front, 68¼ in.; back, 67 in.
Firebox material	Copper
Firebox, plates	Sides, ½ in.; back, ½ in.
Firebox, plates	Crown, ½ in.; tube, ½ in. and ⅞ in.
Firebox, water space	Front, 4 in.; side, 3 in.; back, 3 in.
Firebox, crown stays	1⅛ in. "Brown" iron
Firebox, stay bolts	1⅛ in. copper
Tubes	Material, brass and copper; length, 151⅝ in.
Tubes	Number, 170; diameter, 2 in.; thickness, Nos. 12 & 15
Heating surface, tubes	1,114 sq. ft.
Heating surface, firebox	80 sq. ft.
Heating surface, total	1,194 sq. ft.
Grate	Style, wrought iron; C. iron dump
Grate area	15.2 sq. ft.
Exhaust pipe, style	Single
Exhaust pipe nozzle	3 in., 3¼ in. and 3½ in.
Smokestack, inside diameter	15¾ in.
Smokestack, top above rail	13 ft. 5 in.

Tender.

Weight, empty	27,000 lbs.
Frame	Steel
Wheels	Number, 6; diameter, 37 in.
Journals	Steel, 4 in. by 8 in.
Wheel base	9 ft.
Tank capacity, water	2,100 gals.
Tank capacity, coal	5 tons

STEEL VERSUS WOODEN CABS.

The relative advantages of wood and metal cabs have been considered by all mechanical officers and locomotive designers, and it probably looks to many that the future development of American locomotives will involve a much more extensive use of steel cabs conforming to the almost universal practice in foreign countries. Considerable can be said on both sides of the question.

In favor of metal cabs: Increased strength and durability, and thus lower cost of maintenance.

Against them: Greater first cost and increased weight.

Steel cabs are standard on all Southern Pacific lines, and their mechanical engineer, Mr. F. W. Mahl, says that the first steel cab built was in 1891 on the Southern Pacific system in Arizona. In July, 1895, nothing had been expended for repairs. Since 1895 no wood cabs have been built. In 1895 a number of 22 by 26-inch mountain locomotives were built with steel cabs. Nothing has been expended on them for repairs. It is reported that paint on metal cabs lasts longer than on wood. The Southern Pacific cabs are lined and have double roofs,

and are said by engineers and firemen to be as cool as wooden ones.

Against steel cabs: An increased first cost and increased weight. At present prices of material average steel cabs cost $100 more than wood. Their increase in first cost is probably justified, however, in view of the saving in maintenance. The increased weight is a more serious feature. Comparison of the weight of average designs roughly shows for small cabs 900 pounds increase, and large ones 1,300 pounds. Some special designs show 1,500 pounds or higher. This increase prohibits the use of steel cabs in some new designs where all possible must be done to save weight at the back end of engine to keep within driving wheel weight limits and obtain maximum boiler power. This would apply to many recent designs of large passenger engines, examples of which will readily occur to all. In other types the extra weight of steel cabs may improve the distribution. Many cases will occur in which increased weight is allowable in renewals where railroad men have latitude in new work as bridges and track get stronger and the bridge and track department grow less conservative.

Steel cabs are almost essential also in hot and dry climates, or where moisture and dryness are destructive to wood.—[J. E. Sague.—Topical discussion before Master Mechanics' Association.]

THREE APPLICATIONS OF ELECTRIC DRIVING IN SHOPS.*

Chicago Great Western Railway.

The new shops of this company at Oelwein, Iowa, were planned for electric driving throughout, the system being of the 220-volt direct-current type, with group-driven machine shop tools. The exhaust-steam method of heating is employed, using two fans, each driven by a 25-horse-power motor. An electrically driven transfer table furnishes means for all transferring operations, large and small, the shops being specially arranged to be served from this one table, which travels at a speed of 200 to 400 ft. per minute.

The electrical energy needed in winter, including power required to drive the heating fans, is:

Average electrical horse-power, without lights	325
Maximum electrical horse-power, with lights	450
Night load	65
Nominal motor capacity, horse-power	450
Nominal generator capacity, horse-power	525

The generating station is arranged with three equal units of 150 horse-power, an unusually liberal amount of power for the capacity of the motors connected—a fact in part accounted for by the large percentage of power used to run the heating fans and for the lighting.

General Electric Company's Shops.

The enormous plant of this company, at Schenectady, N. Y., is, as would be naturally supposed, equipped for electric driving, and represents their latest ideas.

In this plant the methods for driving of both light and heavy machinery may be studied. Small and medium size tools are in general driven by the group plan, the short lines of shafting being run by variable-speed motors mounted directly on the ends of the shafts, constituting a novel plan of driving without belting or gears, while large tools are driven by individual motors attached direct or by gearing.

A noticeable feature is the use of portable or shifting tools for very large work. These tools are provided with geared motors, the tool being moved to the work, instead of the work to the tool. This method is especially applicable for the machinery of very heavy and bulky product, but may be used to advantage for special light tools in railway shops, as is pointed out elsewhere.

The entire shops are served by the indispensable electric power crane. These are, in the larger sizes, provided with auxiliary hoists operating at fast lifting speeds for light work.

Their system of wiring and the type of motors deserve special mention. The motors are of the direct-current variable-speed type, and the speed is regulated by a combination of two methods, as follows: The distribution is on the "three-wire" system, the two outside wires having a voltage of 250 between them, while the middle wire carries a potential difference of 125 volts from the other two. The motors are wound for 250 volts, and are connected between the outside wires to run at a certain standard speed; for a lower speed the connections are switched to one outside and one intermediate wire, operating, therefore, at one-half voltage. From this lowest speed to the normal one at 250 volts a gradual speed rise is effected by weakening the magnet strength of the motor field; and, on the 250-volt connections, the motor is further speeded up by again weakening the field. It is seen that these valuable properties of wide speed range are obtained in a very simple manner.

Examples of the speed variation possible in these motors are:

4½	horse-power	motor	runs	at	400	to	800	revolutions	per	minute.
7	"	"	"	"	250	"	500	"	"	"
12½	"	"	"	"	150	"	300	"	"	"
15	"	"	"	"	130	"	260	"	"	"

Baldwin Locomotive Works.

These works illustrate one of the earliest as well as probably the most extensive examples of electric machine shop driving. It is not too much to say that their manufacturing methods to-day hinge largely upon changes made possible by the use of electric power, and that no other agency could be substituted wholly therefor except at incomparably greater expense in space, installation and maintenance. In these immense works, situated in the heart of a large city and employing 8,000 men, the fullest utilization of space and the utmost simplicity and rapidity of handling operations are essential, and many ingenious examples of the convenience and economy of electric driving are here to be seen.

The electric plant is of the 250-volt direct-current type, the generators being direct-connected and aggregating 1,550 horse-power normal capacity. The motors are almost exclusively of the multipolar belted type, and number 320, having a total rated capacity of 3,500 horse-power. Only about 5 per cent. of these motors are of the "series" type—an unusual condition, and due to the fact that the cranes are equipped with shunt motors.

About 950 horse-power at the powerhouse switchboard is required on an average to run the entire power plant, and this figure is fairly constant throughout the day.

Electricity was first introduced in the erecting shop for driving two 100-ton traveling cranes, and an immediate saving of 80 men in the laboring force was thereby effected. The possibility of this result is seen when it is noted that a crane is capable of lifting an entire locomotive, or the parts of same, thus allowing the erection of a large number of locomotives to be carried on in a contracted space and without interference or delays connected with manual handling operations. Hand-drilling operations were also largely reduced in this department by substituting electric portable drills.

In the wheel shop large economies resulted from electric driving. By remodeling the shop the overhead shafting was done away with, each lathe being equipped with a separate motor. The two long main aisles formerly necessary for handling the work in and out of the machines were utilized for additional lathes, giving about one-third more machines in the same floor space; and the shop was served by an overhead traveling crane, instead of the hand jib-cranes in former use. The result was a reduction of common labor force from forty men down to six, and a reduction of the time consumed in reloading a lathe from thirty to five minutes. The saving in power for this shop was also considerable, estimated at fully 50 per cent.

Similar results followed the introduction of electric driving in the frame shop, where the cutting out of overhead shafting and the use of traveling cranes enabled them to cut down the laboring force 60 per cent.

In all the above cases the use of cranes was made possible only by the electric driving of the tools to be served by them.

The motors are, in general, connected to large individual tools by belting from a self-contained countershaft and speed-changing drive mounted on a frame connected with the tool. Group-driving is employed for small tools from short-line shafts.

The cranes are of the single-motor type, having a shunt motor belted to a train of gearing and clutches. This type of crane is highly thought of in these works, and is considered superior to the three-motor type in its smoothness of action, ease and accuracy of handling and reliability. It is, however, higher in first cost than the latter type.

The cost of electric power at these works has been estimated at about $1,200 per week, which sum includes cost of fuel, engineers and firemen, labor and material for repairs of power-house, lines and motors. It also includes interest and depreciation on first cost of plant. It is interesting to note that this entire amount is about 1.2 per cent. of the shop pay-roll.

* Appendices to report on Power Transmission by Shafting vs. Electricity. Master Mechanics' Association. See American Engineer, July, 1900, page 230.

(Established 1832)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY BY

R. M. VAN ARSDALE,

J. S. BONSALL, Business Manager.

MORSE BUILDING..NEW YORK

G. M. BASFORD, Editor.

E. E. SILK, Associate Editor.

AUGUST, 1900.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*
Remit by Express Money Order, Draft or Post-Office Order.
Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburg, Pa.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

A letter from a young stenographer which appears under Correspondence in this issue suggests what we consider one of the best opportunities for improvement in railroad service, the development of humanics in all departments. We withhold the name of the writer of this letter at his own request, and we commend the spirit of honest ambition which he expresses. We are glad to print this protest against indifference toward one of the most important fundamentals of organization and management. There are many cases of people who "do not trouble themselves greatly with the advancement of subordinates" and the number of roads looking outside of their own forces for leading men is becoming alarmingly large. As a broad principle it should never be necessary to look beyond our own subordinates for a man to place in a responsible position, and if the subordinates are selected carefully and encouraged systematically there will always be a candidate at hand who is ready for advancement. As to this young man, can anyone give us the name of the railroad he is looking for?

A 600-h. p. four-cycle gas engine at the works of the John Cockerill Company, Seraing, Belgium, showed excellent results in a recent test. The gas is obtained direct from the Bessemer blast furnaces and, on its way to the engine, passes through dust collectors and receives a proportion of steam to cool it and increase its density. In the tests the thermal efficiency of the engine was 27.16 per cent., the net efficiency about 20 per cent., and the mechanical efficiency between 73 and 80 per cent. The consumption of gas was about 31 cubic meters per horse-power hour. Of the total amount of heat supplied, 20 per cent. was converted into work, 20 per cent. went out in the exhaust, and 52 per cent, into the circulating water.

The New York harbor fire horror of June 30 surprised everyone because of the feeling that the fire protection of modern ships was adequate to prevent such disasters. The rapidity of the spread of the fire and its extent were overwhelming, not allowing time for preventives to be brought into action. The lesson to be learned from this loss of 175 lives and $7,000,000 worth of property is an important one, because a similar combination of circumstances may occur at almost any time in New York. Better piers of steel and concrete, with fire-resisting partitions, are needed. Cotton bales of the cylindrical type are known to be much safer than the old forms which contributed to this disaster. Fireproofed wood is now available and may be used in ships with no disadvantage except a slightly increased cost. The cabin and stateroom ports, or "dead eyes," should be made large enough to admit the body of a man. The most horrible feature of the whole disaster was the death of many whom the would-be rescuers could see and talk with through these openings, which were not large enough to permit of escape. There seems to be no reason why these things can not be done.

Malleable iron is being sold as cast steel for small castings, and the fraud as discovered recently in the department of tests of one of the large railroads, is interesting. A casting bought as cast steel, and for which the corresponding price was paid, was accidentally broken and the fracture was that of malleable iron. Complaint was made to the makers and the part returned as proof. This brought indignant protests from the manufacturers and the sample was returned to the purchasers, but the appearance of the fracture had changed and it then looked like that of tool steel, so fine was the grain. This transformation interested the test officer of the road to the extent of a patient investigation, which revealed the fact that the fracture of malleable iron may be changed to that of very hard and fine steel by heating and chilling. By doing this, fractures at one end of a piece of malleable cast iron may be so much like that of fine steel as to deceive even the expert, while that at the opposite end is the characteristic fracture of malleable iron.

"There are two peculiarities in the compound not brought into general notice, which are of inestimable value to the railroad, perhaps as much so as all the other advantages combined," said Mr. W. S. Morris of the Chesapeake & Ohio at the recent Saratoga convention. "One of these is that of starting a heavy train as compared with the simple engine. The simple engine can seldom start its train without taking slack, and often repeats this process three or four times. The consequent shocks to draft rigging and cars are well known, and are probably the hardest part of the service, few riggings being strong enough not to be subjected to a strain far in excess of their elastic limit. The starting of the compound differs considerably in this respect from the simple engine, especially since enginemen have become familiar with the handling of the machine. There is no need of taking slack, and consequently the slack that generally exists in the train before starting is taken up with care and gentleness, and brings the engine to an apparent standstill about the time when all couplers are stretched. From this moment the actual starting takes

place, and, as there is no lost motion left, there can be no appreciable jerks in the train. This valuable advantage cannot be overestimated, as it necessarily reduces the repair expenses and prolongs the life of the rolling stock in general. The other peculiarity is the possibility of utilizing from 33 to 35 per cent. of the weight on the drivers for tractive power in emergency. This feature, however, is not so easily explained, but makes it possible to handle the trains under all conditions without resorting to the destructive utilization of the slack."

The comparative evaporative values of the various tiers of tubes in a water tube boiler in terms of evaporative power have been obtained by Messrs. Niclausse of Paris, the builders of the Niclausse water tube boiler. A specially constructed boiler was used, with 24 tubes in 12 stages of two each. Each stage delivered its steam separately and was independently supplied with feed water, which was carefully measured. The results are available in a paper read before the British Association by Mr. Mark Robinson, and reported in "The Engineer," Sept. 22, 1899. The tests were carried out at rates of combustion varying from 10 to 61 pounds per square foot of grate, and the remarkable result was obtained that the proportionate evaporation in each stage of tubes was almost exactly the same at all rates of combustion. The lowest stage of tubes directly exposed to the radiant heat evaporated nearly one-quarter of the whole, the first three stages evaporated nearly one-half, and the first six stages evaporated two-thirds of the whole. The first three rows of tubes gave 7½ square feet of heating surface per square foot of grate, and the first six rows gave 15 to 1. The top row evaporated but 3¾ per cent., and the law of decreasing efficiency was plainly indicated. The water tube boiler lends itself very nicely to a test of this kind because of the convenience with which the evaporation may be measured in sections, and it would be a great help in locomotive designing if the same was true of fire tube boilers. The tubes which add but little to the valuable heating surface are just as heavy as those which are more efficient and in the locomotive the front ends of tubes are as heavy as the back ends. The relative value of each foot of length under the working conditions of present practice would be most valuable information.

The opinion of the merits of large grates by an intelligent and observing fireman are worthy of most considerate attention. Mr. Fulton in his article in this issue says a number of convincing things about the large grate. Two of them stand out prominently as good business reasons for increasing grate areas. First the limitations of the physical strength of the fireman. Unless larger grates are used there will be serious agitation for two firemen on every large engine, and it will soon be necessary to come out in the open and call them both "firemen" instead of calling one of them a "brakeman" or "coal passer." We have now reached the extraordinary record of five tons of coal shoveled through a locomotive firedoor in an hour, and in contrast with this let us note that in the most successful stationary practice, where good firing is sought in connection with best efficiency, only one ton per hour is expected of one man. He is fully occupied in placing this amount properly on the grates. In England three tons handled in a passenger run of 150 miles is considered very severe. The second point made by Mr. Fulton is the possibility of burning poor coal. The time will come when the grates will be studied with special reference to the coal used and the active area of fire will be adjusted in accordance with the special requirements of the fuel. In the combustion of locomotive fuel there is a wide and promising field for experiment and investigation, and the way motive power men are taking up the increase of grate areas for soft coal seems to us the most promising improvement ever made in American locomotive practice. It will soon seem strange that grates were kept narrow so long and that the grate area question has been considered as largely independent of the quality of the fuel. The strength of the opposition to larger grates for soft coal seems to have come from the famous opinion of D. K. Clark: "There may be too much grate area for economical evaporation, but there cannot be too little, so long as the required rate of combustion per square foot does not exceed the limits imposed by physical conditions." This celebrated experimenter based this conclusion on tests made with coke, and his opinion, we believe, has been accepted in locomotive practice without appreciating that fact. It is now evident that firebox and grate proportions must be considered with reference to the characteristics of the fuel, and we are justified in placing this subject among those of first importance in locomotive progress.

NOTES.

The water tube boiler has had a marked effect in increasing the permissible amount of heating surface in marine practice. With less weight in the boilers than was formerly necessary, the heating surface is much more liberal. In a review of the warship construction in 1899 in the English Navy "Engineering" states that the minimum for the year was 2.4 square feet per indicated horse power against 1.7 square feet formerly.

An inexpensive dust guard, which has given excellent service and has been adopted as standard on the Southern Pacific System, is made of common pine wood and lined on both sides by either old plush or canvas (canvas preferred), and fastened with clout nails. The hole in the wood is ¼ inch larger than the axle on which it is to be placed, and the hole in the canvas is smaller than the axle fit. When put on the axle it makes a snug fit, and after being in service for a short time becomes saturated with oil, collecting all dust, and is practically dust proof. These dust guards, which cost but nine cents each, were spoken of very heartily by Mr. V. Lemay in a recent paper before the Pacific Coast Railway Club.

In 1879 the car accountants expressed the opinion that "the per diem plan for the use of cars is not feasible." Twenty years later they resolved that "this association is in favor of a per diem method of settlement for the use of cars." The "Railway Age" takes comfort from this mark of progress and says that in only one department of the transportation industry to-day are there great leaks. That department is the freight car service. With the constantly decreasing margin between ton-mile revenue and ton-mile cost the responsible financial managements are compelled to seek economies. "Doing this they cannot overlook the fact that a system under which the average freight car movement is only some thirty miles a day is essentially extravagant and wasteful."

The use of chilled cast iron for coast defence turrets is not new. According to Dr. Thurston, writing recently in "Science," the subject was investigated by our government in 1865 and since then about 40 of them have been built for various defences in Europe. Mr. P. H. Griffin, well known for his work in chilled iron car wheels, has recently acquired from the Krupps the control of the Gruson patents in this country, and has formed a company with works at Chester, Pa., for the manufacture of these turrets. With the knowledge of chilled iron which has been developed in this country, together with plenty of the best chilling irons, the process may be expected to improve, and the remarkable characteristics of chilled cast iron may become important in defenses as well as in transportation.

PERSONALS.

Mr. A. E. Taber has been appointed Master Mechanic of the Great Northern at Kalispell, Mont.

Charles R. Tunks, Master Car Builder of the Lake Shore & Michigan Southern, died suddenly June 29, at the age of 50 years.

Mr. J. C. Reed has been appointed Master Mechanic of the Seaboard Air Line at Portsmouth, Va., to succeed Mr. C. B. Royal.

Mr. R. P. Schilling, General Foreman of the Norfolk & Southern, at Berkeley, Va., has been appointed Master Mechanic of the D. L. & W., at Utica, N. Y.

Mr. James T. Wallis has been promoted from the position of Assistant Master Mechanic of the Altoona shops of the Pennsylvania to be Assistant Engineer of Motive Power at Altoona.

Mr. D. F. McBain, formerly Traveling Engineer of the Michigan Central, has been appointed Master Mechanic of the western division of the road at Chicago to succeed Mr. J. G. Riley, resigned.

Mr. L. G. Parish, Master Car Builder of the Lake Shore & Michigan Southern at Chicago, has had his jurisdiction extended over the Toledo division, which was under the charge of the late C. R. Tunks.

Mr. G. S. Edmonds, who was formerly connected with the Mechanical Engineer's office of the New York Central & Hudson River R. R., has been appointed Mechanical Engineer of the Delaware & Hudson.

Mr. H. Monkhouse, formerly Superintendent of Motive Power of the Chicago & Alton, has resigned to become Superintendent of Motive Power of the Chicago, Indianapolis & Louisville, to succeed the late W. P. Coburn, who died suddenly June 21.

Mr. H. T. Herr, formerly with the Denver & Rio Grande, has been appointed Master Mechanic of the Southeast Division of the Chicago Great Western, with headquarters at Des Moines, Ia., to succeed Mr. F. T. Slayton, who has resigned. Mr. Herr was educated at the Sheffield Scientific School of Yale University.

Mr. L. G. Barger, who was for many years connected with the transportation department of the West Shore Railroad, and recently with the New York Air Compressor Company, has accepted the position of chief clerk to Superintendent Ketcham on the Morris & Essex Division of the Delaware, Lackawanna & Western Railroad.

Mr. George D. Brooke, formerly Master Mechanic of the St. Paul & Duluth, has been appointed Master Mechanic and Master Car Builder of the Iowa Central, at Marshalltown, Ia., succeeding Mr. B. Reilly, who has resigned. Mr. Brooke is succeeded by Mr. J. H. McGoff, under the management of the St. Paul & Duluth by the Northern Pacific.

It is reported that Mr. R. N. Durborrow, Superintendent of Motive Power of the Philadelphia, Wilmington & Baltimore, has been transferred to the same position in the Buffalo & Allegheny division, with headquarters at Buffalo, and that Mr. Alex. Kearney, Master Mechanic at West Philadelphia, will succeed Mr. Durborrow on the P. W. & B.

JASPER R. RAND.

Jasper R. Rand, who died Wednesday, July 18, was born September 17th, 1837, in Westfield, Mass., of a family dating its American ancestry from 1635 and including two colonial governors; and which was well represented in the Revolutionary War. He obtained his education in the public schools and academy of his native town and in Fairfax, Vt.

His earliest business connection was with his father, who was a manufacturer of whips when Westfield was the headquarters of that industry. In 1865 his father retired from business, and Mr. Rand and his younger brother, Mr. Addison C. Rand, succeeded him.

In 1870 he removed to New York and was for a time associated with another brother, Mr. Albert T. Rand, President of the Laflin & Rand Powder Company. In 1872 Mr. Addison C. Rand began the manufacture of the Rand rock drills and other mining machinery, and the two brothers subsequently organized the Rand Drill Company, with Mr. A. C. Rand as President and Mr. J. R. Rand as Treasurer, which arrangement continued until the death of Mr. A. C. Rand in March, which left the chief office vacant, when Mr. J. R. Rand was elected to the position. From small beginnings this business has developed into an important industry. When the Messrs. Rand became interested in rock drills, they were in the pioneer stage, with—apparently—a small and uncertain future before them, but they have come to be an essential part of every mining outfit. Rock drills were among the first American machinery products to find recognition among foreign engineers, and they are to-day at work in nearly every country on the globe where the mining industry has passed beyond the most primitive stage.

In 1873 Mr. Rand removed his residence to Montclair, N. J., where he had ever been prominent in local affairs. For three years he served on the Town Council; was for two years a chosen freeholder of Essex County; a charter member and first President of the Montclair Club, serving also another term; for fifteen years he was a trustee of the Congregational Church. He was one of the organizers of the Bank of Montclair, of which he was continuously the President. He was a member of the New England Society, the Hardware Club and Engineers' Club of New York City, and for forty years a member of the Mt. Moriah Masonic Lodge of Westfield, Mass.

He was practically acquainted with every field of business life from that of traveling salesman up. He had a remarkable fund of wit and of pointed but stingless repartee, which made him the most delightful of companions—qualities which naturally brought him friends without limit. These and other qualities also made him a presiding officer under whose gavel it was a delight to sit. He was interested in all public enterprises and contributed generously to their support.

He leaves a widow, a daughter and a son, the latter now representing the Rand Drill Company in Paris.

THE STOREHOUSE.

Methods of handling storehouse stock touch the economical operation of railroads very closely. Mr. John M. Taylor, General Storekeeper of the Illinois Central, said before the Western Railway Club last month that the delay in handling requisitions and the uncertainty of getting material were responsible for a large proportion of the money that is tied up in storehouse stock. He recommended telephone connection between the storehouse and all of the shop departments, with a system whereby an operator at the exchange could take orders from the shops for material and have the required number of boys under his direction to get the orders, have them filled, and deliver the required stores without involving the loss of time of expensive men in coming to the storehouse.

A comparison of the different shops on a large system on the basis of the proportion of the total value of stock issued

each month, was recommended as a good way to keep the department up in efficiency. A record of the total value of stock in each storehouse and the percentage handled during the month, showed at a glance the amount of dead stock, and such a plan was found advantageous in putting storehouses upon a commercial basis. The storehouse distributing 60 per cent. of its stock each month showed at once the superiority of its management over the one handling but 15 per cent. As in a mercantile establishment, the one in which the stock is "turned over" the greatest number of times in a year is the one to get the greatest benefits from its investment.

Price books and record books of all kinds are recommended very freely by writers on subjects of this kind. It seems strange that the advantages of the card catalogue system have been so slow in coming before those who are keeping complex railroad records. The price book or record book of any kind is at once at a disadvantage because of being a book. If the records are kept on cards, changes and renewals or substitutions may be made at any time without the serious inconvenience of re-writing the entire record when this becomes necessary because the book is full. Cards, kept in a suitable case, are as a general principle to be considered as not only more convenient but much more flexible in a record system.

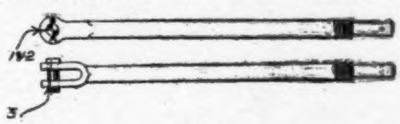
Mr. Taylor has mentioned one of the important, but often neglected, factors of good shop as well as storehouse practice, light. He says: "The storehouse should have good light. Dark corners result in storing material out of sight, an expensive practice. All material that can be so accommodated should be carried on shelving, divided off into compartments of suitable size."

RELATIVE STRENGTHS OF IRON JAWS.

Malleable and Wrought Iron.

A comparison of the ultimate tensile strengths of wrought-iron and malleable-iron jaws used in interlocking signal work was recently made at the laboratory of the Massachusetts Institute of Technology. The tests were made for the Union Switch and Signal Company in connection with the extensive electro-pneumatic switch and signal installation at the new South Terminal Station in Boston.

The wrought-iron jaws were made in the usual form, Fig. 1,



Fg 1.

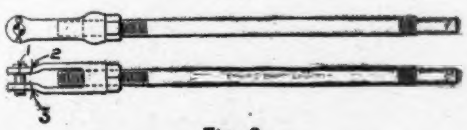


Fig. 2.

of round iron, of the size of 1-inch pipe, and fitted at the ends opposite to the jaws for the usual screwed and riveted connection to the 1-inch pipe which is used for working the switches. The malleable jaws are known as "screw jaws," because they are threaded upon the ends of the rods. They are employed where small adjustments in the length of the connections are necessary.

General opinion has favored the solid wrought-iron jaws as being stronger than the malleable-iron screw jaw, but these tests, instead of confirming this, point in the opposite direction, and indicate that the malleable screw jaws are much stronger than those of wrought iron. Three specimens of each form were tested. The wrought jaws of Fig. 1 broke at the point indicated in the sketch, two of them breaking in front of the pin and the other at the side of the pin. The average strength of these was 23,317 pounds, and the variation was not large in the three cases. The malleable jaws of Fig. 2 broke at the points, 1, 2 and 3, only one being at the pin. Breaks 2 and 3 were in the bends of the shanks, indicating that greater strength might be expected from an improved form at these points. The malleable jaws gave an average of 32,443 pounds, which is 9,126 pounds more than the figure for those of wrought iron. These figures are higher than the strength of the usual screwed and riveted pipe connections, which were also investigated in these tests. Three of the connections between the jaws and the pipes to which they were joined gave an average strength of 26,010 pounds, which indicates that the malleable jaws are superior and the wrought jaws inferior to the pipe joints in strength. The sections of the jaws of both kinds are of approximately the same area at corresponding points, which reduces the comparison of the jaws to a question between wrought and malleable iron as a material for such purposes.

These figures are interesting in their bearing upon the use of malleable iron in connection with air-brake rods and forks.

THE PURCHASING AGENT AND SPECIFICATIONS.

The place of the Purchasing Agent in railroad organizations was suggestively discussed by Mr. Ira C. Hubbell in a paper read before the Western Railway Club in March, in which he expressed hearty sympathy with the idea that the purchasing department should not be considered as a separate and distinct institution, but rather as a co-operative branch of each of the three great departments to which the operation of the modern railroad is intrusted, and that the Purchasing Agent should be, ex-officio, a member of each of them, as an expert in his particular line.

Mr. F. A. Delano had found closeness of touch with the purchasing department of great value, and thought it a mistake to locate the offices of the mechanical and purchasing departments miles apart, as was true of many roads. The two departments should co-operate, and the Purchasing Agent should be taken into the confidence of the Superintendent of Motive Power. The Purchasing Agent should attend the meetings at which the mechanical men discuss the needs of the department. All this indicates the desirability of breaking down the sharp department lines of the past for the sake of harmony, in which there is much to be gained.

In discussing the subject of specifications, Mr. F. W. Sargent stated that he had received specifications calling for a test bar on steel castings, where the test bar was longer than the castings.

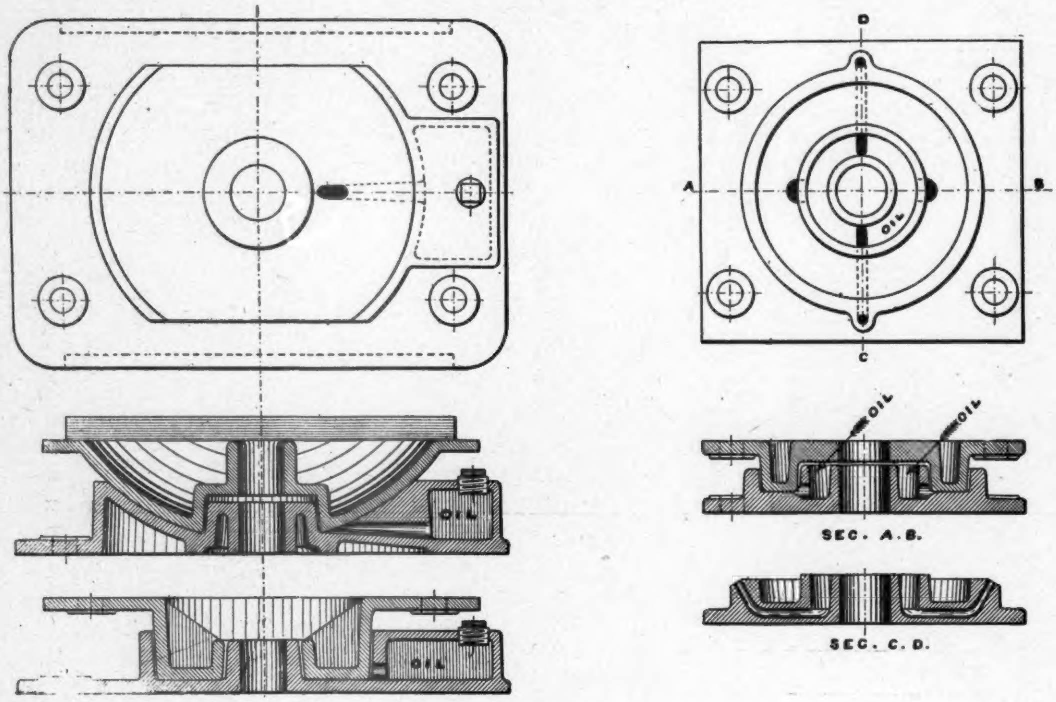
Iron which is suitable for staybolts on one road is equally suitable for another, and yet nearly every road has its own specifications. Some of the requirements may be met at moderate cost, while others involve unnecessary expense. It seems entirely practicable to adopt standard specifications for many kinds of material, and the advantages would soon be apparent in the prices. This seems to be a wise and practicable idea.

The oil engine, says "Engineering," is rapidly settling down to one pattern, the variations being in the working of the valves and small matters of that kind, and not in matters of principle. In commenting upon the recent exhibition at York, England, it was said that the expiration of the Otto patents allowed all makers to adopt one design and there was no longer any demand on their ingenuity in evading its claims. At this exhibition special attention has been noticed with reference to lubrication, brushes being provided to catch the overflow of oil from the crankshaft bearings so that none could be lost. One of the large engines was fitted with a self-starter. This comprises a hand pump fitted alongside the cylinder. In using it, the exhaust valve is first propped open and combustible mixture is pumped into the cylinder until all the air is expelled. The valve is then closed and a further supply of combustible mixture pumped in. A valve at the top of the ignition tube is then opened, and the mixture flows up the incandescent tube until it fires and explodes the charge. The engine then gets away, and the ordinary cycle is taken up.

THE DAYTON LUBRICATING CENTER PLATE.

The necessity of lubrication of center plates was a prominent feature of the report upon this subject at the recent convention of the M. C. B. Association, several forms of lubricated center plates having been illustrated in the committee report upon this subject. Among them was the Dayton lubricating center plate, manufactured by the Dayton Malleable Iron Company under the patent owned by them. The name of the manufacturers, however, was not given in the report.

Our engravings show the construction of this center plate, which provides an oil pocket in the lower plate to keep the wearing surfaces constantly flooded with oil. It is made of malleable iron and the chamber is provided with a screw plug which may be removed for the addition of oil while the truck is under the car. This method of lubrication will greatly reduce the friction between the plates and its effect upon the



The Dayton Lubricating Center Plate.

wear of wheel flanges and the resistance of trains is exceedingly important.

A test was made in the warehouse of this company for determining the comparative resistance between dry and lubricated center plates. Service conditions were, as far as practical, duplicated; but it is not claimed that exactly the same results were obtained as are given by regular service. The plates used were taken from stock, and were not finished nor treated in any way, but used exactly as they came from the rattlers. The lower plate was secured firmly by bolts to the floor, and the upper one to a platform 8 ft. 6 ins. square, the plates being engaged as in service with the exception of the king bolt, or center pin, which was not inserted. Castings to the aggregate weight of 20,000 pounds were loaded on the platform and distributed to keep the platform balanced and bring all the weight on the center plates.

The platform containing the load was revolved by means of a windlass, a pointer being attached to one corner, and the movement was sufficient to cause this pointer to travel through an arc 6 ins. in length. The movement was effected by means of a tackle block attached to the platform at a point directly above that where the flange of the wheel would come in contact with the rail. The other end of the tackle block was attached to one arm of a bell crank, and the other arm of this crank rested on an ordinary pair of platform scales. The pivot of the bell crank was secured to one of the posts of the warehouse, and the tackle block was pulled by means of a windlass in order to give a continued, regular movement. The first load weighed was 2,000 pounds, and readings were taken as each additional 1,000 pounds were applied up to an aggregate weight of 20,000. The test was in this way made, first, with dry plates; the load was then entirely removed, the platform lifted, and the lower plate and oil chamber filled with oil, after which the test was repeated under exactly similar conditions and with duplicate weights. It will be noted from the figures that, as the travel of the platform increased, a greater amount of pull was acquired for turning it. This is owing to the fact that the angle of the pull increased as the platform revolved. It was found that the amount of pull depended largely on the speed at which the movement was made, and in making all tests this movement was made at as slow a speed as possible. With heavier weights—that is, above 12,000 pounds—readings were taken at each inch of the movement of the platform.

From a large number of readings the following are reproduced:

Pounds Pull Required to Turn the Platform.

Weight.	Dry.	Lubricated.
2,000	150 to 225	40 to 47
15,000	600	155
20,000 to start	850	200
20,000	1 in. travel 900	210
20,000	2 in. travel 1,000	275
20,000	3 in. travel 1,035	235
20,000	4 in. travel 1,085	245
20,000	5 in. travel 1,125	265
20,000	6 in. travel 1,200	275

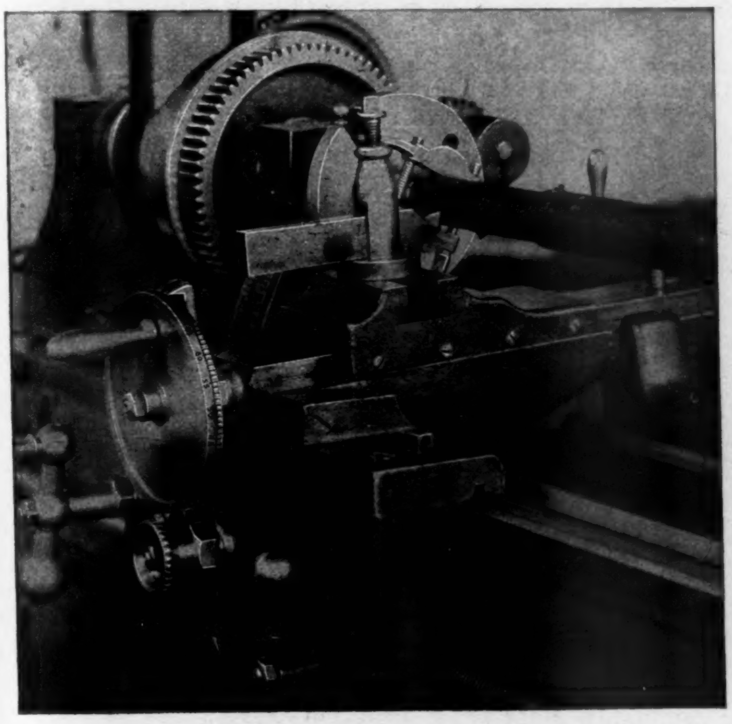
From these figures it appears that the frictional resistances of these lubricated center plates are less than one-fourth of those of dry plates.

"The oil and not the pigment of paint," says a well-informed correspondent, "measures the life of paint, although some high authorities hold to the contrary, I believe. The pigment should be considered as the boards of a fence and the oil as the nails. Then as soon as the weather rusts out the nails the boards fall off. In a similar way the weather eats out the gum and the life of the oil, and off comes the pigment."

GRADUATED DIALS ON LATHE CROSS SCREWS.

A great deal of money may be saved in machine shops by a relatively small investment in micrometer calipers together with graduated dials on the cross screws of machine tools. J. T. Slocomb & Company, manufacturers of micrometers, Providence, R. I., have used dials, as illustrated in the accompanying engaving, for a number of years and the idea seems to us excellent. They do not make them, but strongly advocate their use. They are not expensive and they certainly save time, labor and spoiled work. Several makers put these dials on their lathes, but they are usually too small in diameter and the graduations are too fine. At the shops referred to the discs are fitted in the place of the usual ball crank. A straight fit is turned on the quill extending from the lathe apron, and the pointer, which is split and held by a binding screw, is fitted to it.

They permit of turning sizes for accurate fits by the most



Graduated Dials on Lathes.

direct methods possible and without the usual "cut and try" process. The work is simply rounded up and measured with the micrometer, which shows how many thousandths are to come off; then, by the reading on the dial, the cutting tool is adjusted to take off the exact amount desired, with little chance for mistake and securing a great saving of time. These people say that any machinist of ordinary ability will never give them up when he has employed them long enough to become used to them. J. T. Slocomb & Company manufacture calipers for all-around machine shop work and they recommend them in place of all other outside gauges for work that is at all close. These micrometer calipers used in connection with the micrometer dials fill two "long-felt wants"; first, an accurate method of measuring work, and second, an accurate way for adjusting cutting tools in accordance with these measurements.

Although the most valuable feature of the dials is in adjustment for sizes, they have other uses. These manufacturers use them instead of the usual screw-cutting stop in cutting screw threads. This permits of accurately gauging the depths of cuts and avoids the troublesome springing of most screw-cutting stops, which renders it difficult to take fine finishing cuts. With the dial a 7/16-in., 14-thread screw on short work, is started with five 0.005-in. cuts, followed by six cuts of 0.003 in. and finished by a cut of 0.001 or 0.002 in. All guessing is avoided and the work is very easily duplicated for any desired number of pieces. Taper turning is equally simplified by this attachment and the dial may also be used for measuring the extent to which work is "out of true," and for measuring cuts on inside work in places difficult of access.

It is evident that judgment and experience are required in handling such work, and the lack of accuracy of most feed screws must be guarded against. The variations often amount to 0.006 in. in the length of a screw, but this will cause no trouble with short work. These people say that the dials are somewhat confusing at first, but, speaking from experience, they find that it does not take long to become accustomed to them. The dial must, of course, be graduated to fit the pitch of the feed screw. For an 8 P. screw they use dials 5 in. in diameter, graduated in 125 divisions by short lines for thousandths and every fifth line extended and numbered. One division on the pointer is graduated to quarter thousandths. One division therefore reduces the diameter one-half thousandth.

THE "DEUTSCHLAND."

The twin-screw steamship "Deutschland" of the Hamburg-American Line made on her maiden trip an average of 22.42 knots per hour for 3,044 knots from Plymouth to Sandy Hook, arriving in New York July 12. Her daily runs were 308, 557, 553, 551, 532 and 543 knots, making the trip in 5 days, 16 hours and 15 minutes, which beats the best previous record of western trips. On the return trip another new record was made to Plymouth in 5 days, 14 hours and 6 minutes, the average speed being 23 knots.

By courtesy of Mr. Emil L. Boas, General Manager of the line, the ship was opened to visitors in New York. In appearance the "Deutschland" resembles the "Kaiser Wilhelm der Grosse," but is longer by 38 ft., and has 7,000 more indicated horse-power. The "Deutschland" is 686½ ft. long, her breadth being 67½ ft. and depth 44 ft., and displacement 16,000 tons. The engines are in two sets, quadruple expansion, with six cylinders each. The indicated horse-power is 35,000. There are 12 double and 4 single boilers, having 112 furnaces. Her propellers are 23 ft. in diameter. She has six decks, 17 water-tight compartments, and a double bottom divided into 24 chambers. She has accommodations for 467 first class, 300 second class and 300 steerage passengers. A large play room for children, and gymnasium on the promenade deck, are available to first class passengers, and a grill room upon the boat deck, open until midnight. The promenade deck is 520 ft. long. The ship has bilge keels and her appointments throughout leave nothing to be desired for comfort and convenience.

NELS YELLOW SIGNAL LIGHTS, C. C. C. & ST. L. RY.

The Superintendent of Telegraph of the "Big Four," Mr. C. S. Rhoads, writes of his experience with Mr. John C. Baird's new glass in signals in strongly favorable terms. In a recent test made on the open road, away from the view of conflicting city lights, he found that he could get a good view of the red at a distance of two miles. The green was also clear at that distance and, he thinks, slightly clearer than the red. The yellow glass, however, gave a distinct indication at a distance of three miles. Mr. Rhoads says: "The more I see of the yellow, the better I am pleased with the change we have made in connection with the green as a clear signal. Our system is being changed to conform to the new standard, taking one division at a time."

It is pleasing to see such confirmation of the opinion of this yellow glass, which this journal has repeatedly expressed. The question of the color of signal lights has not received much attention from motive power officers, but if they interest themselves in it they will not only contribute important assistance, but will find it a subject in which they are very directly concerned, viz., one which has to do with the loss of time of trains. It would help the reform in signal lights if the mechanical department officers should consider this subject before the railroad clubs. They really know more about the requirements of signal lights than anyone else. The cost of running fast trains is so great as to warrant consideration of every question tending toward the certainty of signal indications.

"DIAMOND S" BRAKE SHOES AT PARIS EXPOSITION.

Appreciation of "Diamond S" brake shoes is not confined to the railroads using them in the United States, but it has extended to roads in all parts of the world. The exhibit at Paris, which is shown in the accompanying engraving, is in charge of the Paris representative of the company, Mr. Rochette. The exhibit consists of new and worn "Diamond S" brake shoes with bundles of expanded metal and records in the form of tables and diagrams showing the performance and the effect of the shoes upon tires. The enclosure of the exhibit is a network of expanded brass in a framework of wrought iron. The arch at the top of the front of the booth represents a section of a tire with a brake shoe in position. Altogether the exhibit is

**The International Brake Shoe Co.
Paris Exposition.**

an attractive one, and its prominent position in the midst of the locomotive exhibit brings it to the attention of all interested in railway appliances. The patents on this brake shoe, outside of the United States, are controlled by the International Brake Shoe Company. This concern is now supplying brake shoes to railways in England, France, Italy, Russia, Turkey, India, South Africa, Central and South America, Mexico, Canada and other countries. The president of the company, Mr. W. D. Sargent, recently returned from a very successful trip abroad. We are informed that the International Brake Shoe Co. has been awarded the silver medal, which is the highest award given this class of appliances at the Paris Exposition.

RAILROAD ROLLING EQUIPMENT IN THE UNITED STATES.

According to the figures of the Interstate Commerce Commission there were 36,703 locomotives in the service of the railways on June 30, 1899, or 469 more than the year previous. Of the total number reported, 9,894 are classed as passenger locomotives, 20,728 as freight locomotives, 5,480 as switching locomotives, and 601 are not classified.

The total number of cars of all classes in the service of the railways on June 30, 1899, was 1,375,916, an increase of 49,742 being shown in this item. Of the total number, 33,850 are assigned to the passenger service, 1,295,510 to the freight service, and 46,556 to the direct service of railways. It should be understood, however, that cars owned by private companies and firms used by railways are not included in the returns made to the commission. The report under review contains summaries intended to indicate the density of equipment and the extent to which it is used. It appears that the railways of the United States used on the average 20 locomotives and 734 cars per 100 miles of line; that 52,878 passengers were carried, and 1,474,765 pasenger-miles accomplished, per passenger locomotive; and that 46,303 tons of freight were carried and 5,966,193 ton-miles accomplished per freight locomotive. All of these items show an increase when compared with corresponding items for the preceding year ending June 30, 1898. There was also a decrease in the number of passenger cars per 1,000,000 passengers carried, and a decrease in the number of freight cars per 1,000,000 tons of freight carried.

Both locomotives and cars being embraced in the term equipment, it is observed that the total equipment of the railways, on June 30, 1899, was 1,412,619. Of this number 808,074 were fitted with train brakes, the increase being 166,812, and 1,137,719 were fitted with automatic couplers, the increase in this item being 228,145.

Practically all locomotives and cars in the passenger service were fitted with train brakes, and of 9,894 locomotives assigned to that service 6,128 were fitted with automatic couplers. Nearly all passenger cars were fitted with automatic couplers. With respect to freight equipment, it is noted that nearly all freight locomotives were equipped with train brakes and 45 per cent. of them with automatic couplers. Of 1,295,510 cars in the freight service on June 30, 1899, 730,670 were fitted with train brakes and 1,067,338 with automatic couplers.

A GRACEFUL ACKNOWLEDGMENT.

Mr. Bowen R. Church, leader of Reeves' Band, who furnished the delightful music at the recent convention at Saratoga, was presented with a fitting testimonial after the adjournment of the conventions and the presentation was made in the following letter, which was signed by the presidents of both associations and the committee of the Supply Men's Association:

"The members of the Master Car Builders', American Railway Master Mechanics' and Railway Supply Men's Associations, represented at the Saratoga Convention held in June, 1900, as a token of their appreciation of your willingness in the past to give them individually, as far as in your power, any selections they desired, and for your efforts at all times to please them and their guests, present to you this diamond ring, the brilliancy of the stone being only eclipsed by the delightful music furnished by you and your band. We hope that long life may be given you to enable you to wear this memento for many years to come."

BOOKS AND PAMPHLETS.

Railroad Operations: How to Know Them. From a Study of the Accounts and Statistics. By J. Shirley Eaton, Statistician of the Lehigh Valley Railroad. New York: The Railroad Gazette, 1900. Price, $2.00.

This book was intended specially for managers, investors, students and railway experts. It is written from the standpoint of an expert who is a close student of railroad statistics and one thoroughly informed upon his subject. There are few books in this field, and the great and increasing importance of properly prepared statistics renders such a work particularly appropriate. The recent years of business depression have induced close watching of every department for the discovery of possibilities for saving. The discussion in the press and among railroad men, of particularly interesting annual reports, was never so common before, and we take this as an indication that railroad methods will be more closely studied and carefully com-

pared as the number of opportunities for saving decrease. We should say that Mr. Eaton has written also for the department officers because a careful examination of the book will suggest many improvements to many officers, such as the chief engineer, division superintendent and superintendent of motive power. The author treats not only of dry figures, but offers many sensible suggestions. Under "Reducing Expenses" he says: "The order is 'retrench.' It comes as an emergency, with no time to parley. It follows that much retrenchment lacks method. Sometimes they adopt a rule of cutting requisitions in two. A master mechanic needs just 60 feet of belt for his shop engine and the manager reasons that for economy he must cut the requisition in two, and the shop is delayed for 30 feet of belting." Managers do more foolish things than this. Such retrenchment as adding two more cars per train, reducing train mileage and increasing net earnings is advocated. Many of the ideas concerning management are old, but no one can glance through the book without being instructed or reminded as to possible improvements. It will be seen by the following list of chapters that the author is more than a statistician: Hints for Examining Railroad Property; Watching Freight Traffic Currently; Expenses; Passenger Traffic; Reducing Expenses; Examining Earnings; Car, Engine and Train Movement Statistics; General Principles of Interstate Commerce; Classification of Expenses; Maintenance of Way Expenses; Maintenance of Equipment; Conducting Transportation; General Expense; Public Statistics; Operating Units; Averages; Prorating; Railroad Statistics; Expense Classification; The Earning Classification; Working Tools for the Statistician; What is Cost? Capital and the Fundamental Theory of a Railroad.

We approve the author's arrangement of putting the historical at the end. It is the least important part of the work, but is not without interest and value. To the reviewer the fundamental ideas of the author seem to be two: 1, To show the principles of railroad statistics. 2. To show how they may be used currently by the men in charge of operation, to obtain better results. The frequent use of the word "current" indicates a broad idea of what statistics are for, not alone for the investor, but for the operator, and to us the latter use is of the more vital importance to the owners of the property. It is evident that the author advocates the use of figures by the various division superintendents for the comparison of their work month by month and of that of other divisions.

A high place is given to the ton-mile unit, which Mr. Eaton considers the best single unit thus far offered, but it is shown to be necessary to have other units also. We find the book much more interesting and a great deal more valuable than the title seemed to indicate. It should be read by every manager, superintendent, motive power officer and purchasing agent.

Railway Signaling. By H. Raynor Wilson, of the Lancashire & Yorkshire Railway, England. Published by the Publishers of "The Railway Engineer," 8 Catherine Street, Strand, London, England, 1900. Price (in England), 18 shillings.

This long-promised book has appeared in greater part in the columns of "The Railway Engineer," and it is now brought up to date and enlarged. The author desired to prepare a standard work covering the entire subject of railway signaling, but the phenomenal growth and development of the electric side of the subject necessitated separate treatment, the work before us being confined to mechanical apparatus. The author has confined himself to apparatus which represents sound practice in England, and we nowhere find the appearance of a desire to merely record experiments. The work is divided into the following chapters: Single Lines; Signal Cabins; Wood and Iron Posts; Point and Signal Connections; Locking Frames; Signaling plans; Level Crossings; Examples of Large Signaling Installations; Board of Trade Requirements and standard specifications for signaling works. The author is a master of his subject and has used excellent judgment in the plan and execution of the work. Giving due regard to the historical, he gets at once into present-day questions and in this he is especially to be commended. He presents the principles and details of English methods and gives working drawings of everything used about mechanical interlocking except those devices which must be bought from the manufacturers, such as train staff apparatus. Every signal engineer and operating officer should secure a copy of this book, because of the large number of suggestions which may be obtained from such a thorough record of English practice, and because of the opinions of the author on many points of practice. The book is altogether the best that has ever appeared on the subject of signaling, and not the least valuable features are the Board of Trade requirements brought up to date, and a reproduction in full of the standard signal specifications of the Great Eastern Railway. The book contains a number of large folded plates of signal and switch plans for such terminals as the Waverley Station, Edinburgh; the Liverpool Street station of the Great Eastern Ry., and the Waterloo terminus of the London & Southwestern. From correspondence with the author and in other ways our expectations concerning this work have been high and the result is not in any way disappointing.

Standard Designs for Boats of the United States Navy. Specifications, Schedules of Material, Weights and Cost. By Chief Constructor Philip Hichborn, U. S. N., Chief of Bureau of Construction and Repair, Navy Department, Washington, D. C. Government Printing Office, 1900.

The standard navy boats have been evolved from experience and careful study of the special conditions to be met in the naval service, and the excellent work before us is a complete record of the present construction, even to the speed trials of the various steam launches. Each boat is represented by working drawings, shear, half breadth and body plans, specifications, bills of material, weights and actual costs. For completeness, arrangement and excellence of execution this book has not often been surpassed, and the impression of conscientious thoroughness in design of these boats is at once received. It is evident that the navy department has made good use of the New Bedford whaleboat in its designs for boats of relatively light carrying capacity, and the models for launches of large capacity have been worked out with equal care. The volume is in every way creditable, and the half-tones of complete boats are unusually fine. We cannot see how anyone can help being stirred with admiration for the 30-foot gig whaleboat of Plate 159, which is one of many illustrated. Such work as this in a relatively small matter connected with a war vessel increases the confidence that our naval interests are in the hands of the right kind of men.

American Railway Association. Proceedings Covering the Period from 1894 to 1898, Inclusive. Published by the Association, 24 Park Place, New York, N. Y. Price, $5.00.

This is the second volume of the proceedings of this Association and the records of its important work from the beginning up to and including the convention of 1898 are now available in a form which is convenient for reference and preservation. To our readers it is not necessary to say anything about the value of these volumes, but we take this opportunity to direct attention to the great amount of work which the secretary of the Association, Mr. W. F. Allen, has done to put the proceedings into this form, and to compliment him upon the character of the presentation.

Mechanical Equipment of the New South Station, Boston. By Walter C. Kerr. A reprint of a paper read before the American Society of Mechanical Engineers, December, 1899.

This paper is unique and very valuable. We have already referred to it in our columns. It presents a description by the contracting engineers of the interesting work connected with the design and installation of the mechanical equipment of the largest railroad station in the world. The variety of the work and its extent, together with the exceedingly exacting conditions, render it worthy of study by many who are not specially engaged in station work, because the various factors in this aggregation are sufficiently extensive to compare with installations for towns of considerable size. This is specially applicable to the lighting problems. There are twelve separate branches of engineering represented in this undertaking, all of which was intrusted to Messrs. Westinghouse, Church, Kerr & Company. These are as follows: 1. Power-house. 2. Interlocking switch and signal system. 3. The electric plant. 4. Heating and ventilating. 5. Disposal of drainage from waterproofed structure. 6. Roof drainage. 7. Ice-making, refrigerating and water-cooling plants. 8. Car heating in train shed and yards. 9. Air-brake charging. 10. Steam and hot water supply to head-house. 11. Fire protection. 12. Elevators, baggage and express lifts. The entire work was handled as a unit, and this is to us its most interesting feature, as it is a departure from the usual practice of calling in a number of

experts in the various branches of engineering represented and giving them commissions to work independently. In this case the responsibility was concentrated and the work was not only better done, but a great deal of money was saved. The fact that a single firm is prepared to conduct such an enterprise is significant of the high place which Westinghouse, Church, Kerr & Company have attained. Such a paper as this should be placed in the hands of investors and others who are responsible for the large railroad terminals of this country. Copies may be had from the Westinghouse Companies Publishing Department, Pittsburg, Pa.

Traveling Engineers' Association. Proceedings of the Seventh Annual Convention, Held at Cincinnati, Ohio, September, 1899. Edited by the Secretary, Mr. W. O. Thompson, Elkhart, Ind.

The annual volume of proceedings of this energetic Association contains the record of the last convention and discussions of the following subjects: "The use of water on hot bearings of locomotives and tenders;" "How can the responsible engineer be located when an engine has been subjected to unfair usage under the pooling system?" "The proper care of the air pump and engineer's valve while in service, and what is essential to the successful handling of air brake trains;" "In employing or recommending young men for firemen, what qualifications should they possess?" "Long runs of locomotives, with a view of economical treatment, and maintenance;" "Is it economy to use the exhaust steam from the air pump to heat the feed water?" "Eyesight tests;" "Boiler compounds and purges."

"The Foundry" for June, 1900, contains an admirable article by Paul Weaver upon brass furnaces, which we commend to our readers who are using the familiar "hole in the ground" method of melting brass. The author states a strong case for improved furnaces as to economy of fuel, and also in the service of crucibles. "The Foundry" is published at Detroit, Mich.

Among the special features of the July Magazine Number of The Outlook will be found a collection of portraits and pictures relating to the present Chinese crisis, including several never heretofore printed, and of unusual interest; an article on the political career and character of Joseph Chamberlain by Mr. Justin McCarthy, the author of "The History of Our Times" and "The Story of Gladstone's Life," with portrait; an account of a "Visit to the Prince of Montenegro," by E. A. Steiner, with many pictures; an elaborately illustrated article on Lourdes, "A Town of Modern Miracles," by Clifton Johnson, who furnishes also the photographs reproduced; an illustrated article on "The Religious Situation at Harvard," by Mr. Durant Drake; a singular story called "The First Judas," by Florence M. Kingsley, whose novel of early Christian times called "Titus" achieved such an extraordinary success; another instalment of Mr. Hamilton W. Mabie's series of illustrated articles on Shakespeare, and several other illustrated and unillustrated magazine articles, together with the usual full historical review of the world, editorials and other departments. ($3 a year. The Outlook Company, New York.)

Pneumatic Tools, 1900. The Q & C Company have issued a new 50-page pamphlet on the subject of their pneumatic tools, including hammers, drills, riveters, stone-cutting hammers and flue expanders. The illustrations, which are very good, show the tools assembled and in groups of parts, each part being numbered for reference in ordering. This catalogue is specially commended for the clear and concise descriptions and the good engravings.

Westinghouse Friction Draft Gear. A pamphlet prepared in the usual admirable style of the Westinghouse companies presents an elaborately illustrated description of this interesting device. Our readers will remember the description on page 148 of our May number and in the pamphlet they will find not only a description, but transparent interior views of the gear, records of tests and a number of illustrations of methods of application of the draft gear to the framing of cars and tenders. The appearance of the pamphlet is opportune, because of the increase of interest in the subject by the increasing capacities of locomotives and cars. Readers are advised to secure copies from the Westinghouse Air Brake Company.

"Standard Steel Rails and Splice Bars Manufactured by Carnegie Steel Company, 1900," is the title of a handsome volume in flexible leather, containing all that engineers need for reference to the steel rails used on the railroads of this country. The rail sections of the various roads, tables of rails, splice bars, spikes, specifications of rails, and the names of the roads using each section are given. The dimensions are stated in metric and English units. In every way it is worthy of the Carnegie Steel Company. We have received a copy through the courtesy of Mr. A. R. Peacock, First Vice-President of the Company.

"Record of Recent Construction No. 19" of the Baldwin Locomotive Works contains a number of interesting designs, among which we note the H5 freight locomotive of the Pennsylvania; a heavy 10-wheel engine for the C. & O.; a compound consolidation for the Bavarian State Railways; a compound Atlantic type passenger engine for the Central of New Jersey, and a number of engines for home and foreign roads. The closing illustration in the pamphlet shows a small tank engine with 9 by 14 in. cylinders for Mr. Arthur Koppel. It is built for a 23⅝-in. gauge and weighs 25,550 lbs. The service includes curves of 59 to 66 ft. radius. These pamphlets are always in excellent taste and their value as a record of the work of the largest builders of locomotives is doubtless appreciated.

"Electric Train Lighting from the Car Axle." We have received from Mr. Jno. N. Abbott, Vice-President and General Manager of the Consolidated Railway Electric Lighting & Equipment Co., a copy of a handsome pamphlet bearing this title. The apparatus was described in our issue of December, 1899, page 400, except as to the method of driving the generator, which has been improved and simplified. The pamphlet presents in a number of fine engravings the adaptation of the system to coaches, mail and special officers' cars. This company also controls a system of refrigeration, making use of its axle-driven generators. Besides the excellence of the light, absolute safety from conflagration in case of wrecks is strongly urged for this system.

The Hayden & Derby Manufacturing Company, 85 Liberty Street, New York, have issued a new price list and catalogue, 44 pages, 6 x 9 in., dealing with the various types of Metropolitan Injectors and H. D. Ejectors of which they are the sole manufacturers. The catalogue is finely illustrated and has for a frontispiece an excellence view of the company's plant at Bridgeport, Conn., one of the most complete and modern establishments of its kind in the world. In addition to a detail description of the Metropolitan Automatic Injector, Metropolitan "1898" Injector, and Metropolitan Double-Tube Injector, the book contains much interesting information on the subject of injectors generally, with suggestions as to the proper type and size injectors for the most satisfactory and economical results. Special attention is directed to what these injectors will accomplish under various conditions. Copies of the catalogue may be obtained upon application to the Hayden & Derby Manufacturing Company, and they should prove of value to engineers and steam users for ready reference.

"Concerning Roller Side Bearings" is the title of one of the most attractive little pamphlets of its kind we have seen this year. It is issued by the Simplex Railway Appliance Company, Fisher Building, Chicago, and is devoted to the Susemihl side bearing. This device is the result of about 15 years' experimental work by Mr. F. G. Susemihl, of the Michigan Central R. R., and in its present form it has been used continuously for three years without developing defects. The arrangement of the rollers compels them to roll with the movements of the trucks and the rollers are kept out of contact with each other; furthermore, they cannot drop out of the bearings. When the car is jacked up from the trucks the parts of the bearing all go with the upper bearing, and they cannot fall out or become lost. The principles of the construction were illustrated on pages 339 and 394 of our October and December numbers, 1898, but several important improvements have been made since that time. At the recent Master Car Builders' convention the question of side bearings was considered one of the two most important subjects for discussion, because of the effect of side bearing friction upon the net hauling capacity of locomotives. It seems to be the general opinion among car men that if roller bearings can be so constructed that the rollers will not flatten in service they will be used because of the possibility which they offer of reducing the weight necessary to make the bolsters

sufficiently rigid to sustain their loads without deflection. We go further than this and believe that roller side bearings are necessary anyway, even with stiff bolsters, and the design referred to here seems to meet all requirements.

Metal Sawing Machine. The Q & C Company have issued a new catalogue of power sawing machines, portable rail and shop saws, in which attention is called to the fact that this company are the only manufacturers of cold metal saws of both the arbor and blade driven types. They are consequently in position to recommend whichever type seems from their experience to be best adapted to the purchaser's requirements. They also call attention to the arrangement of their power machines, which permits of cutting structural iron work in the positions which involve the least length of cut, which leads to a great economy in time. The portable rail saws and shop saws have been improved in many ways to increase their convenience and durability. These machines are illustrated in a large variety.

The passenger department of the New York Central has issued a folder on Bronx Park and the pilgrimage system of teaching. This gives complete directions for visiting the New York botanical gardens and museum, as well as the other features of the famous Bronx Park, and the other side of the folder is devoted to an itinerary for a trip through the country on the New York Central near New York, which is full of historical interest from its connection with the American Revolution. The number of short trips about New York and the actual knowledge of history, geography, geology, botany and (at the Bronx Park) zoology, which may be obtained in a short time and at a very small cost, is surprising. A copy of the folder will be sent on receipt of a postage stamp by Mr. Geo. H. Daniels, General Passenger Agent, New York Central Railroad, New York.

"The New Pennsylvania Limited" is described in a pamphlet which is unique and beautiful, published by Mr. E. A. Ford, General Passenger Agent of the Pennsylvania Railroad. The literature of the passenger and advertising departments of our best railroads has improved wonderfully during the past few years. It contains many examples of high art in printing and illustration, but it seems impossible to surpass this of the Pennsylvania. The cover is in the cream and olive-green colors of this train and the printing, engraving, paper and binding are finely executed. The illustrations are half-tones from photographs actually taken on this train, and they exhibit a degree of luxury and comfort equal to those of the best clubs and hotels. Copies may be obtained from the General Passenger Agent.

The White Mountains of New Hampshire are conspicuous in many ways. The region is one grand wonderland, and every turn brings the visitor to some attraction in which Nature's marvellous embellishments are displayed. The famed "Crawford Notch," "The Flume," "The Old Man," "Elephant's Head," "The Lake of the Clouds," the Gulf, the ravines and cascades are but a few of the many notable features with which it would seem this region has been so extravagantly endowed. One hardly realizes how imposing the mountain surroundings are until a visit has been paid them, but a slight idea of some of their principal attractions may be gained from perusing the "Mountain Hand-Book," issued by the Boston & Maine Railroad, and for pictorial views of the mountains the Boston & Maine portfolio known as "Mountains of New England," will prove interesting and instructive. The first mentioned book is sent for a two-cent stamp, the latter for six cents in stamps to any address upon application to the Passenger Department of the Boston & Maine Railroad, Causeway Street, Boston, Mass.

EQUIPMENT AND MANUFACTURING NOTES.

Mr. Jere Baxter of the Tennessee Central is in the East to buy equipment for that road. It is expected that he will place orders for about $500,000.

Owing to increased business, the Modoc Soap Company have found it necessary to enlarge their manufacturing facilities by moving into a new five-story brick building, No. 119 West Second street, Cincinnati, in which their capacity is greatly increased. This became necessary in order to meet the demands of railroads for Modoc Liquid Car Cleaner, which is used by nearly all the leading railroads of the country for cleaning passenger cars.

The International Power Company have just delivered ten 10-wheel compound locomotives to the Chicago Great Western Railway for passenger service. The parts made in cast steel are the driving wheels, driving boxes, link hangers, reverse shafts, low-pressure piston, rocker shafts and cross heads. They have Nathan lubricators, Ashton safety valves, Richardson valves, Westinghouse brakes, Sargent brakeshoes and Ajax bearings.

Through inadvertence we failed last month to refer to one of the most attractive exhibits at the recent Saratoga conventions—that of William Sellers & Company. Their locomotive injectors, new water strainer, boiler check and valve. and combination check and stop valve were exhibited and all of them attracted a great deal of attention and interest.

Lucol paint has been selected for use on the 1,200 high-sided coal cars which the Wheeling & Lake Erie are building at their Ironville shops. With this paint the cars are painted and stencilled, ready for the road, in twelve hours, which is a decided advantage over slow-drying paints under such circumstances. In a recent experiment with Lucol paint on this road, one of the new cars was sprayed at 7 a. m. At noon it was dry and was sprayed with a second coat. At 5 p. m. it was dry enough to stencil and at 6 p. m. it was in a train with a load of coal.

Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, Chicago, Ill., who returned to Europe on the "Kaiser Wilhelm der Grosse," on July 3d, for an extended stay at the Paris Exposition, invites customers and friends of the company who visit the Exposition to call on him at their exhibit in the American Machinery Building, Vincennes, in Space 1, Block 9, or at the Palace of Machinery and Electricity, Champ de Mars, Space 1, Block 14, where he will be pleased to meet them and extend any courtesies that will be acceptable in looking up points of interest.

The Chicago Grain Door Company, Monadnock Building, Chicago, has received within the past 60 days the following orders for its grain door equipment:

"Soo" Line, 3,000 cars.
Northern Pacific, 1,000 cars.
Great Northern, 1,000 cars.
Chicago, Milwaukee & St. Paul, 1,000 cars.
Atchison, Topeka & Santa Fe, 500 cars.
Illinois Central, 2,500 cars.
Intercolonial Ry. of Canada, 1,100 cars.
Canadian Pacific of Canada, 1,200 cars.

It is safe to say that the most attractive exhibit at the recent M. C. B. and M. M. Association conventions was made by the Pintsch lighting people. Their display occupied a very prominent place, for it was located in the lobby of the Grand Union, while the other exhibits were to be found out in the court-yard and along the veranda. The framework upon which the various styles of Pintsch lamps were suspended was finished in white and gold, backed with heavy plate mirrors. The four styles of lamps shown thereon were all gold-plated and equipped with either cut glass bowls or bowls of chased glass with empire designs. A novel feature consisted of a dining car table spread with beautiful linen and fine napery and holding all the correct table appointments, highly polished silver, pretty tea service and beautiful china. Over this table extended a two-branch silver-plated gas candelabra showing how useful and effective an ornament it would be in dining cars. A white and gold screen afforded a display place for five or six styles of lamps for side illumination, which might be well employed by railroads of this country where they want novel effects in first-class coaches, parlor and dining cars. Some of the styles shown were a Roman torch design, a three-branch gold-plated candelabra and an argand bracket lamp. The beauties of this exhibit were enhanced by beautiful potted palms placed around the platform and a judicious use of Eastern rugs, while the chairs at the dining table and those to be used by visitors were of mahogany, handsomely designed and with leather seats. The light as usual was brilliant and the whole exhibit added greatly to the cheerfulness of that part of the Grand Union.

MASTER CAR BUILDERS' ASSOCIATION.

Thirty-fourth Annual Convention.

Abstracts of Reports.

(Concluded.)

TESTS OF MASTER CAR BUILDERS' COUPLERS.

Committee: W. W. Atterbury, W. S. Morris, W. P. Appleyard, H. Monkhouse, F. A. Delaho.

It will be remembered that at the last meeting of the Association, the general subject of the "Master Car Builders' Coupler" was considered of sufficient importance to warrant the appointment of a standing committee of five, the work of the committee to be somewhat of the character of your standing Committee on Brake Shoes and Triple Valves.

The work of your committee during the last year has been largely that of perfecting the details of the work submitted at the last meeting of the Association, and has, therefore, been as yet unable to do any work on the more serious question, that of the tests of the Master Car Builders' couplers.

Drop Testing Machine.

The drop testing machine which has been adopted as recommended practice has now been thoroughly developed and the detail drawings form a part of this report.

Subsequent to the last meeting of the Association, Purdue University, through Prof. R. A. Smart, with the approval of the late President Smart, and subject to the approval of its trustees, made a proposition to your committee to the effect that a drop testing machine, of the design approved by your committee, be constructed by the university at its expense, under the direction of your committee; that such machine, when built, shall be the property of Purdue University, and shall be installed in its laboratory, to be at all times subject to the use of the Master Car Builders' Association, through its proper committee, for official research, the university to furnish such aid and assistance and subsidiary apparatus as may be convenient; the machine to be at all times usable by Purdue University for educational and commercial purposes; all of the above to apply to any improvements in the machine which may be devised by your committee.

The Association will note that the conditions are practically those under which the Master Car Builders' Brake Shoe and Air-Brake plants have been installed, except that in this case the plant would be the property of the university.

Your committee submitted the proposition to the Executive Committee and was by it empowered to act in the matter, and has, therefore, believing the proposition to be exceedingly fair, taken it up with Purdue University, and is now awaiting advice of the favorable action by the trustees of that institution.

Your committee hopes that before the next meeting of the Association this drop testing machine will be constructed and in operation and some definite results obtained from the same.

Worn Coupler Gauge.

The secretary of the Association was authorized, and has arranged with the Pratt & Whitney Company, of Hartford, Connecticut, to manufacture this gauge, and your committee is advised that at the present time 241 of these gauges are under process of construction.

Coupler Contour Gauge.

This gauge, which was somewhat modified, with the approval of the Association at its last meeting, is now being manufactured by the Pratt & Whitney Company, and the members of the Association should be able to obtain them on order.

Twist Gauge.

The twist gauge, as approved as "recommended practice" at the last meeting of the Association, has been in use experimentally by your committee for some little time, and some slight changes and modifications have been found necessary. Your committee does not feel warranted, as yet, in placing this gauge in the hands of a manufacturer, as there is a possibility that a more extended trial will demonstrate that some further changes may be required.

Marking of Master Car Builders' Couplers.

In view of the fact that some couplers are bought on time specifications, it has been suggested that a method of marking similar to that now in general use on air-brake hose be adopted for couplers.

In the event of the proposed method meeting the approval of the Association, your committee would further recommend that it be embodied in the specifications and the same changed to read as follows:

"The name of the coupler and class of bar must be cast on the top side of head of bar in letters and figures three-fourths inch long and raised one-sixteenth inch. Each drawbar must also have plainly cast upon it the Master Car Builders' standard label of dimensions and size, and in the location as shown in detail on drawing which forms a part of these specifications. Each knuckle must," etc.

Increased Dimensions of Shank of Coupler.

Your committee has given this subject considerable thought, but is not at present prepared to recommend an increase in the dimensions of the shank of the coupler, in view of the fact that such radical changes as the committee would desire to make will necessitate very material changes in such standards of the Association as pertain to the spacing of center sills, location and dimensions of draft timbers, etc.

It is possible that the development of the metal center-sill or metal draft-timber may bring about such a design of these parts as will permit the use of a coupler with an increased shank. Before this matter can be definitely settled it may require a joint meeting of your standing Committee on Couplers and your Committee on Draft Gear.

Master Car Builders' Coupler Knuckle.

As the interstate commerce law in regard to the use of automatic couplers becomes operative on August 1, 1900, the necessity for the link and pin disappears. Your committee believing, therefore, that the time for the abandonment of the link-pin hole and slot is now at hand, hereby ask for such discussion of the subject as will enable your committee to intelligently make its recommendations.

DRAFT GEAR.

Committee: J. R. Slack, James Macbeth, W. E. Sharp.

In order to obtain information as to the practice and experience of the various roads in regard to draft gear, circulars containing 16 well-directed questions were sent to the members of the Master Car Builders' Association.

For convenience the different forms of draft gear used have been divided into classes, which are designated as follows:

A.—One double-coil spring with cast-iron stops bolted to wooden draft timbers. This is the ordinary form of Master Car Builders' recommended practice.

B.—Twin springs with malleable-iron cheek pieces or draft arms bolted to wooden draft timbers.

B^1.—Twin springs side by side, with malleable-iron draft arms bolted to the sills of car.

C.—Twin springs placed side by side, with malleable-iron cheek pieces bolted to wooden draft timbers.

D.—One double-coil spring, as in type A, but with pressed steel or malleable-iron stops.

E.—One double coil spring with malleable-iron cheek pieces or draft arms bolted to wooden draft timbers. In this type, as in type B, the front and back stops are in one piece with the draft arms, so that the pulling and buffing strains are distributed among all the bolts holding the draft arms, instead of the bolts holding each stop acting separately, as in types A and D.

F.—Draft rigging of the Graham type.

G.—Draft rigging of the American continuous type.

H.—Four two-coil springs arranged side by side in tandem.

The number of roads using the different classes of draw gear is as follows: A, ten roads, B, six roads; B^1, four roads; C, one road; D, two roads; E, three roads; F, five roads; G, two roads; H, one road. One private car line uses four forms—A, B, E and G; one road uses D as a standard, but also has in use forms B and C; one road uses B as a standard, and also has in use E; one road uses F as standard and also has in use H; one road uses D as standard and also has in use B and C.

For type A the following figures are given for cost of maintenance: Twenty-five to 30 cents per year; \$1.60 per car per year; \$1 per car per year. A private car line which has types A, G, B and B^1 in service gives the following ratio of cost of maintenance: A, 1; B, 0.16; G, 0.45; B^1, 0.12. A road using type B reports no repairs except those due to wrecks. A road using type E gives 30 cents per car per year. A road using type C reports very rare failures during a service of eight years. A road using type E reports cost of maintenance scarcely anything. A road using type F reports \$1.20 per car per year.

The weak points reported are: One road reports trouble with type E on account of the use of not properly seasoned timber, which shrinks and allows the keys to become loose, thus putting the draft bolts in shear. This fault should not properly be laid to this type of draft gear. One road using type G reports trouble due to the bending of the draft key and stretching of the draft rods on account of the increased tractive force of the locomotives. A private car line finds the same fault with this type. Two roads using type A report trouble on account of the followers chafing against the draw timbers and cutting into the wood. One road reports trouble with type A on account of loosening draft timber bolts by gradual working lengthwise of draft timbers, not wholly prevented by draft timber keys. One road using type A finds that the trouble with it is that as it gets old the wooden draft timbers splinter and give way, and another that there is not good enough connection between draft lugs and draft timbers and subsills. Another road using type D reports one of the weak points is that as it has no good bearing on the draft timbers, and the bolts have to take a good deal of the thrust, the bolt holes are thus elongated, allowing end motion of the draft rigging. The majority of answers are to the effect that no weak points have been found with the particular style of draft rigging used.

Seven roads report having used metal draft arms principally of malleable iron. Ten roads have used metal cheek pieces, with front and back stops cast together and bolted to wooden draft timbers. Twelve roads have not used such arms. One road reports 2,000 cars equipped with metal draft arms, and states good results have been found. On the other hand, one road reports unsatisfactory results from the use of these arms on cars of iron construction. One superintendent of motive power reports the use of these arms on about 1,500 cars. The general testimony of those who have tried the metal draft arm or the cheek piece bolted to the wooden draft timber seems to be in favor of it.

A private car line reports the malleable-iron draft arms, type B^1, to have been in use about five years. They state the cost

of application to be about $1.50 to $2 more per car, and the cost of maintenance $4.40 per car per annum less. Another road gives the cost of the draft arms, type B^1, as $2.18 per car. This is the road that has about 2,000 cars equipped with these. They state they have had them in service about three years, and have had to renew none to date on account of ordinary service. The private car line above referred to as having types A, B, E and G in service gives the following ratio as the cost of application: A, 1; B, 1.19; B^1, 1.31; G, 1.19. Another road reports the cost of equipping a car with malleable draft arms at $12.50 more than with the Master Car Builders' recommended practice.

Thirteen roads report that they have used pressed steel or malleable-iron stops, and fourteen that they use only the cast-iron stop. One road uses a heavy angle-iron stop. The advantages of such stops over cast-iron stops appear to be greater in strength with less weight of metal. A few roads report unsatisfactory results with the pressed steel stop, but others say the results are satisfactory where the front and back stops are connected by a bar which serves to distribute the pushing and pulling strains among all the bolts holding the front and back stops.

Sixteen roads have used tandem or twin springs instead of the ordinary 6¼ by 8-in. double-coil spring. Eleven roads use only the double-coil spring. One road uses a triple-coil spring. All the roads using a tandem or twin spring find it of advantage in relieving shocks and saving the draft gear. In most cases where the tandem or twin springs are used they are each the same as the Master Car Builders' 6¼ by 8-in. double-coil spring. Three roads consider the 6¼ by 8-in. double-coil spring of sufficient capacity to withstand the pulling and buffing strains of heavy freight locomotives. Twenty-two roads do not consider this spring of sufficient capacity. Of the three roads favoring this spring, however, one uses with its standard draft gear two tandem springs. Another of the three finds that they have more trouble with breakages of the couplers that they are using than with the springs, and consider the springs sufficiently strong for the couplers as now made and for the method of attachment to the draw timbers. This road is using type A draft gear with the ordinary cast-iron stops.

Twenty-six roads consider the use of draw timber keys advisable. Two roads do not favor them.

Fourteen roads report that they have had no experience with the continuous type of draw gear. Eleven roads report their experience unfavorable. Four roads report good results from this type of draw gear.

Twenty-six roads report no experience with rods run from coupler back to second needle beam. Three roads report favorably on such construction. One objection brought against this is the difficulty of keep the rods tightened up as they should be in order to be effective.

The following are the conclusions arrived at by the committee:

1. The ordinary type of draw gear (type A), known as the Master Car Builders' Recommended Practice, is defined in strength both in method of attachment to draw timbers and in capacity of spring. The strains imposed upon this both in pulling and buffing by heavy freight locomotives cause frequent failures and make it an expensive draft gear to maintain.

Appendix A.

2. A form of draft gear of type B^1, with metallic draft beams and twin springs, with draft rods running to needle beams, is the most desirable. Malleable iron is the best material for the draft beams. Buffing timbers should be protected with suitable malleable-iron draft caps. The use of the twin springs is desirable, as it maintains the present standard yoke for coupler.

The committee is not at present prepared to submit any design, but is of the opinion that a proper design should follow the lines as above stated.

In conclusion, the committee would suggest that it might be desirable to make some tests to determine how much of the stock, especially of buffing strain, is absorbed by the two-coil spring and also by the tandem spring, and what is the efficiency of the various methods of attachment to the draw timbers.

JAMES MACBETH,
W. E. SHARP.

Appendix B.

2. A form of draft gear which is a modification of type B appears to be the most desirable form. Instead of using metal cheek pieces bolted to wooden draft timbers, malleable draft arms should be used bolted to the sills of the car, thus doing away with the wooden draft timbers entirely. Draft rods should be run back to the needle beams. Tandem springs should be used and arranged so as to bring them both in action in pulling and buffing. The tandem spring appears to be preferable to the twin springs side by side, as the draft arms can be brought closer together, which makes a better construction, and does not require the use of such long follower plates as the twin springs. The springs used should be the same as the Master Car Builders' standard, 6¼ by 8 ins.

The committee is not at present prepared to submit any design, but is of the opinion that a proper design should follow the line as above stated.

In conclusion, the committee would suggest that it might be desirable to make some tests to determine how much of the shock, especially of buffing strains, is absorbed by the two-coil spring, and also by the tandem spring, and what is the efficiency of the various methods of attachment to the draw timbers.

JOHN R. SLACK.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Thirty-third Annual Convention.

Abstracts of Reports.

(Concluded.)

THE EXTENT TO WHICH THE RECOMMENDATIONS OF THE ASSOCIATION HAVE BEEN PUT INTO PRACTICE.

Committee—F. A. Delano, A. Sinclair, H. Middleton.

[This committee prepared an elaborate preliminary paper stating, briefly, all the important recommendations adopted since 1870, arranged in convenient form, and sent copies to members with requests for statements of practice, the object being to ascertain how generally they were used. Only 23 replies were received, the number of locomotives represented by them being but 6,347. These are too few to indicate how generally the recommendations are followed. The recommendations themselves are reproduced here because of their value, and the replies are omitted.—Editor.]

On the subject of Standard Nuts, Standard Screw Threads, Bolts, Bolt Heads and Standards for Bar Iron:

In 1870 the Association recommended the formal adoption of the U. S. Standard nuts. In 1884 adopted Pratt and Whitney limit gauges for round iron to be used for Sellers' standard thread taps. In 1891 reaffirmed formally the standards of 1870 and of 1884. In 1892 adopted the standard U. S. Standard sizes of nuts and bolt heads and urged on the members of the Association a rigid adherence to the same. In 1899 Briggs' standard wrought iron pipe threads were adopted for wrought iron pipe and couplings as standard.

On the general subject of Boiler Construction, the Association has made a good many recommendations, namely:

In 1871 it recommended steam as better than hand riveting. In 1872 recommended all holes in longitudinal seams be drilled and made to match by reaming rather than by the use of a drift pin; also that hollow staybolts be used. In 1881 recommended machine riveting, especially steam riveting. In 1885 recommended making a clean metallic joint between surfaces to be calked with waste wet with a weak solution of sal ammoniac and hot water. In 1885 that in hydraulic tests for locomotives, hot water 25 lbs. above working pressure be used. In 1889 recommended the double riveting of the foundation or mud rings on boilers. In 1894 drew up specifications for boiler and firebox steel. In 1895 approved a report showing best methods of making a riveted joint and best designs therefor. In 1899 approved a report on best method of applying staybolts to boiler.

As bearing further on this subject in 1880, the Association passed on the subject of the use of Sling Stays and decided:

In 1880 that in crown bar boilers it was essential to use sling stays from the crown bars to the outside shell of the boiler. In 1894 it was recommended that in view of the greater breakage of flue sheets in radial stay boilers, due to the rigid strain of the crown sheets and placing of flues too close to the flange of the sheet, that flexible sling stays should be used to support the crown sheet at the front end. In 1896 it was resolved as the sense of the meeting that a radial stay boiler was as safe as a crown bar boiler and more easily and economically kept clean and in repair.

Bearing on the general subject of boiler construction, some recommendations in regard to Boiler Tubes or Flues have been made:

In 1886 a committee reported on the best plan of removing, cleaning and resetting boiler tubes, and it was voted as the sense of the meeting that it was unnecessary to bead the front end of flues. In 1889 a committee reported that it was almost the unanimous sentiment of the Association that the water space around the firebox should be from four to five inches; that the water bridge between flues should be ¾ in., with 2-in. flues, and that the flues should be set vertical, so as to allow better circulation. In 1895 specifications and tests were offered and adopted for boiler tubes. (See also page 296, 1899.) In 1895 (again) the question was discussed as to a uniform method of computing boiler tube heating surface. Three locomotive works and the Pennsylvania Railroad reported that they figured the heating surface by figuring the outside diameter of tubes, whereas one locomotive works figures the heating surface by figuring the inside diameter of tubes.

In 1896 a slight change was made in the standard size to suit standard gauge. In relation to these recommendations your committee desires to ask the following questions:

Referring to the subject of Standard Tank and Car Axles:

In 1879 the Association adopted the 3¾-in. by 7-in. journal for cars and tender axles of 40,000 lbs. capacity. In 1881 this was reaffirmed. In 1890 adopted the M. C. B. 60,000-lb. axle with 4¼-in. by 8-in. journal for heavy tenders. In 1891 these recommendations were reaffirmed as recommended practice.

Referring to the subject of Side Rods:

In 1882 the Association favored the "I" beam section of side rod. In 1883 approved formulae offered by Mr. F. W. Dean for design of such sections. In 1893 favored the manufacture of fluted or "I" beam side rods by machine work rather than by forging them out.

On the subject of Wire Gauges for Wire, Tubes and Sheet Metal:

In 1882 the Association adopted the Browne & Sharpe micrometer gauge, which was reaffirmed in 1891. In 1895 adopted an elliptical notched decimal gauge. (See also page 291, 1899.)

Under the general heading of the Gauge of Wheels on Axles for Standard Gauge Track:

In 1884 the Association adopted 4 ft. 5⅜ ins. as the standard width between backs of wheels for tender trucks and locomotive wheels with the limits of 4 ft. 5¼ ins. and 4 ft. 5½ ins. These conform with the M. C. B. standard.

Under the general heading of Standard Diameters or Driving Wheels and the question of Tires for Driving Wheels, the Association has taken the following action:

In 1886 certain standard diameters of wheels and standard sections of tire were adopted, varying from 38-in. to 66-in. diameter, inclusive. In 1887 a further report on this matter with the exact inside diameters of tires was adopted and the M. C. B. standard tire section also adopted. In 1893 standard outlines for flanged and plain tires were adopted, and standard sizes of wheel centers from 70-in. to 90-in. were also adopted. (See also pages 293 and 294, 1899.)

The Association has also discussed the question of Wear or Tires:

In 1887 decided that the manipulation of the sand and handling of the brakes by engineers had a great deal to do with the wear of tires. In 1895 an elaborate report on the wear of driving-wheel tires was submitted showing six different causes. In 1896 the question of Counterbalance was considered and its relation to driving-wheel tires pointed out. In 1896 (again) a report was submitted pointing out the best design for reciprocating parts in order to reduce the weight of counterbalance as much as possible.

In 1894 a report on tire treatment made the following recommendations:

Page 206. Retaining rings are necessary on wheel centers above 62 in. diameter. Page 207. Do not run tires with retaining rings any thinner than without them. Page 207. Use same shrinkage with retaining rings as without. Page 205. Drawing of Mansell ring fastening. Page 209. Minimum thickness of tires considered safe: Passenger, 1½ in., last turning; freight and switching, 1¼ in., last turning. Weight on drivers not to be considered. Page 211. Greatest permissible depth of wear of tires: ¼ in. on road engines, ⅜ in. for switch engines, but business conditions must govern. Page 216. Depth of flange permissible: Road engine, 1½ in.; switch, 1⅝ in. Drawings of instruments for measuring wear of tire and flange.

Under the general heading of Relative Proportions of Cylinder to Boilers and Grate Area, the Association has made several recommendations:

In 1887 a formula for the proper proportions of locomotive cylinders was offered. (See page 43.) In 1888 recommendations giving limits for these proportions were offered and approved. In 1897 a report was made giving valuable data as to the proper ratios of heating surface, grate area and cylinder volume for passenger and freight service, burning anthracite or bituminous coal.

On the general subject of a More Economical Combustion, the Association has taken the following action:

In 1881 comparatively high exhaust nozzles were recommended as the best practice. In 1888 the conclusion of a committee reporting on the subject of extension fronts, brick arches, etc., concluded that brick arches were an excellent thing, but should not come closer than 1 in. from the side sheet or 2 in. from the flue sheet; that 90 lbs. of coal per square foot of grate area per hour was about the maximum economical rate of combustion. In 1890 another committee on brick arches stated that the evidence was overwhelming in favor of the brick arch and extension front end. Angle irons and studs for brick arches were preferred to circulating pipes. In 1896 and 1897 a committee offered a very complete report on the proper height of exhaust nozzle and form of stack, recommending a tapered choke stack. In 1899 the Association decided by vote that it was not desirable to use bars in the exhaust nozzle.

Report of Testing Laboratories for Railways.

In 1891 a very complete report was submitted on the subject of testing laboratories for railways, showing their proper organization and province.

On the general subject of Testing Materials:

In 1892 the Association accepted a report making six conclusions, the most important of which was that steel should not be worked at a temperature between normal and a perceptible red heat known as "blue heat." In 1896 the Association again decided that it was of great importance in flanging steel that it should not be worked below a cherry red heat.

Under the general heading of Treatment of Employes, the Association has taken the following action:

In 1886 a resolution was passed that the Association deprecates giving testimonials or recommendatory letters for publication, and enjoins all to restrict matters of this nature to letters of inquiry. In 1891 a report was submitted giving advice to employers as to the best method of examining engineers and firemen, including suggestions on the education of firemen. In 1898 a report was submitted on the subject of apprentice boys and a code of rules adopted by the Association to govern their promotion.

Under the general topic of Compound Locomotives:

In 1893, the Association decided that the compound is suitable for freight service, but that its availability in passenger service was undetermined. In 1899, the Association decided that a by-pass valve to relieve the vacuum in the low-pressure cylinder when drifting was very important.

Under the general subject of Standards for Boiler Attachments, the Association

In 1893 listened to a report making eight recommendations looking to increased safety, and adopted a resolution that the water glass, although a convenience and an additional precaution against low water, was not absolutely necessary to the safe running of locomotives.

Under the heading of Tonnage Rating for Locomotives and Ton-Mile Basis for Statistics the Association

In 1898 considered favorably a report on tonnage rating, and in 1899 adopted a resolution that it was the sense of the meeting that the ton-mile basis for motive power statistics is the more practical and encourage economical methods of operating, etc.

Under the general heading of Chilled Cast-Iron vs. Steel-Tired Wheels for Cars and Locomotives:

In 1888 the Association approved specifications submitted by a committee for the manufacture of chilled wheels, giving a test, form of contract and service guarantee. In 1899, in a report on the relative merits of cast wheels and steel-tired wheels for locomotive and passenger cars, a recommendation (see page 127) was made as to the best method of keeping a record of the mileage of wheels.

On the general subject of the Best Metal for Locomotive Cylinders and Cylinder Bushings the Association has taken the following action:

In 1896 accepted a report on cylinder bushings, making five distinct recommendations. In 1897 accepted a report of a committee making four recommendations in regard to best metal to be used for cylinders, valves and valve seats.

Under the general heading of Locomotive Statistics:

In 1872 the Association adopted a report fixing an arbitrary mileage to be computed for switch engines at six miles per hour of actual service, for local freight engines 6 per cent. for switching, and also that new engines to replace vacant numbers should be charged to repairs, except any excess in cost over the old ones.

JOURNAL BEARINGS, CYLINDER METALS AND LUBRICATION.

Committee—W. C. Dallas, J. B. Barnes, G. F. Wilson.

Question.—Please give the committee what you consider the best cylinder mixture for your heaviest high-pressure engines.

The replies to the question can be arranged in three groups. The first group containing the largest number of replies is from roads which do not operate their own foundries, and they give the uniform specifications, a close-grained iron as hard as can conveniently be machined and prevent castings being subject to shrinkage cracks.

In the second group we have those who operate their own foundries or who purchase cylinders or guarantee to meet specific composition, such specifications calling for various grades of new iron and scrap.

In the third group we have those who have advanced a step farther and added to their specifications the use of a varying percentage of steel scrap with their iron constituents. Roads using specific mixtures as detailed can only be cited as an illustration of the best practice in different parts of the country where the different special irons are in convenient freighting distance, and a universal mixture would be an absurdity. The nearest approach to universality would be a mixture of irons that would give a certain chemical analysis which practice had determined would give the best results. The data at hand, however, is too limited for the committee to go any further.

In this connection it seems to be a general complaint that some of our locomotive builders make their cylinders entirely too soft, presumably for the purpose of facilitating and cheapening the cost of machining, and also assisting in preventing a loss of cylinder castings due to shrinkage causing cracking.

Question.—Do you or do you not get any advantage in casting cylinder saddles separate from the cylinders?

The deduction of the committee from the replies to this question would be that cylinders and saddles in one piece can be so designed, molded and handled in the foundry as to give perfect satisfaction and still be so secured to the frames as to be immovable, resulting in economy, not only as to first cost, but in cost of maintenance, although one road has been for the last two years using the three-piece cylinders and saddles, and from observations made at different times it seems they are having great success not only in keeping the cylinders secured, but they have been able to reduce to a minimum the time in which to apply a new cylinder. The method pursued by this road allows a different metal to be used in the cylinders than that in the saddle; plainly speaking, a hard metal can be used in the cylinders and a softer metal in the saddles. This arrangement seems to have advantages over the two-piece cylinder and saddle. [The method referred to here is that of the classes H5 and H6 locomotives of the Pennsylvania illustrated in our issue of June, 1899, and of the class E1 shown in our issue of June, 1900.—Editor.]

Question.—Please give the committee the best alloy for various bearing metals on your heavy and fast passenger engines.

The question of proper bearing metal for heavy fast passenger service is an important one, but it would seem from the various replies received, each one having good success with their own mixtures, that it is a question for each road to decide, after taking into due consideration designs of engine,

weight on square inch of bearing surface, road bed and ballast conditions, methods of oiling and quality of lubricant used.

Undoubtedly one of the best metals for locomotive bearings and connecting-rod boxes is what is known as "phosphor-bronze," "S" grade:

Copper	79.70 parts.
Tin	10.00 parts.
Lead	9.50 parts.
Phosphorus	.80 parts
	100.00 parts.

The reason the above mixture is far superior to any other is owing to the fact that copper and tin phosphorized gives it a greater affinity for lead, by which it will be understood that by the method of phosphorizing employed copper is made more fluid and in a manner cleaned, which causes it to amalgamate with the lead, and lead being a natural lubricant it has its advantages in the mixture by being held in solution, and in case of a bearing becoming neglected regarding oil for a short period, the lead in a manner fulfils the want of oil.

In conclusion, the committee would state that no matter what the mixture may be, foundry practice assumes almost as important a part as the mixture, to prevent hot bearings, and should be given careful consideration.

Question.—Do you experience any difficulty in lubricating cylinders and valves and machinery on your high-pressure heavy and fast passenger engines? Please give the committee the benefit of your experience on this subject.

To this question, the majority of the roads replying say that with improved lubricators, proper piping and the use of a good lubricant and high grade of oil, they are experiencing very little difficulty.

Commenting on the replies to this question, it is the opinion of the members of this committee that with the modern lubricator, properly applied and operated, very little difficulty should be encountered in securing proper lubrication to valves and pistons, providing a proper lubricant and sufficient of it is used.

Question.—What do you consider the best method of locating oil holes, oil grooves and oil pockets in driving boxes?

Answering this question, the majority of the roads favor oiling journal driving bearings by carrying oil to crown cavity, either centrally from one oil pocket, on top of box, or from two cavities on top of box by means of holes drilled at an angle to reach crown cavity.

The Chicago, Burlington & Quincy Railroad replies that it has tried and is still trying oil holes and oil grooves on the side, and has tried to do away with the center oil hole in the top, but thus far with only moderate success. The trouble seems to be that the waste from the driving box is grated up and soon plugs up the grooves and the oil holes on the rear side, and if the box runs at all warm the metal tends to "wipe" over the groove on the front side. On the whole, it seems that the side oiling is of very doubtful advantage.

The New York Central & Hudson River Railroad favors lubricating at the side just above the center of the axle. Its experience in oiling driving boxes that way has been somewhat limited, although on a number of engines being turned out with holes drilled toward the center of the boxes the result has been very satisfactory.

The Southern Railway of Peru says that it locates oil holes on the sides of journal boxes and has done away with oil grooves and pockets, depending upon the cellars for lubricating the journals.

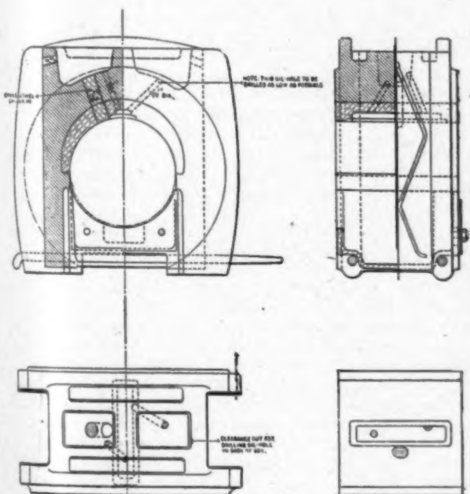
The Boston & Maine Railroad advises that driving boxes are best oiled by two oil grooves running lengthwise of bearing located on each side well away from the crown, oil holes leading to these grooves from large pockets in top of box.

The following roads furnished blue prints of their methods of lubricating driving boxes: Chicago & North Western, Grand Trunk, Canadian Pacific, Oregon Short Line, Chicago Great Western, Mexican Central and Northern Pacific.

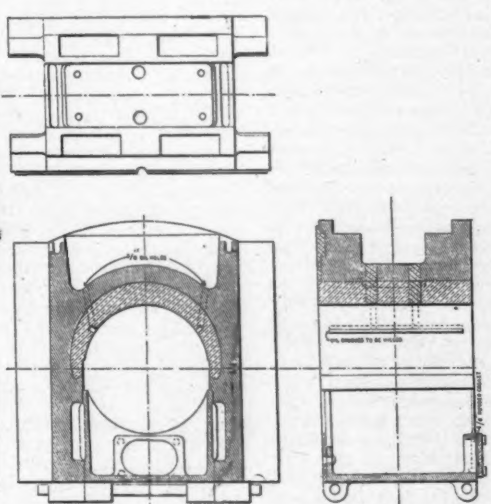
PRESENT STATUS OF COMPOUND LOCOMOTIVES.

Committee—J. F. Deems, A. E. Mitchell, John Player, J. E. Sague, J. H. Setchel.

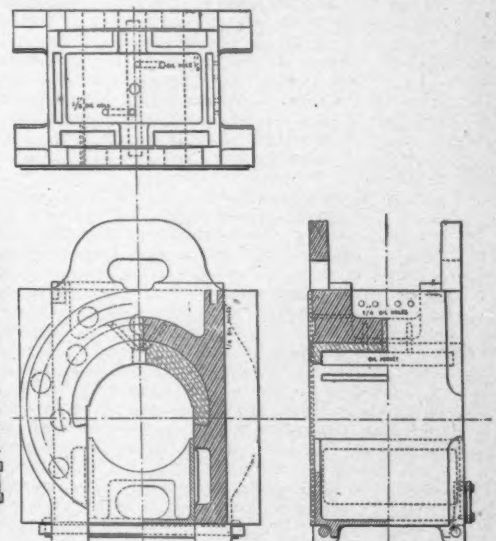
The great source of waste in the use of steam in a single cylinder is the alternate heating action of the entering steam and the cooling effect of expansion and condensation on its walls and the consequent wasteful condensation and re-evaporation of steam. Any expedient which will reduce this waste by preventing the transfer of heat from the steam to the



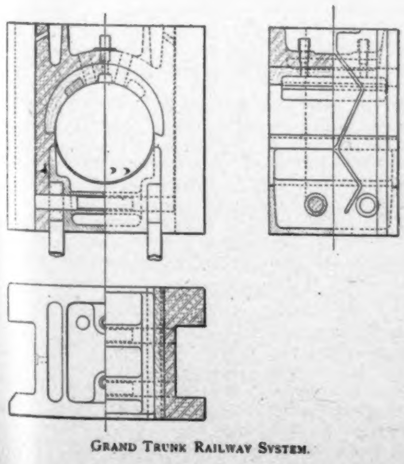
CANADIAN PACIFIC RAILWAY COMPANY.



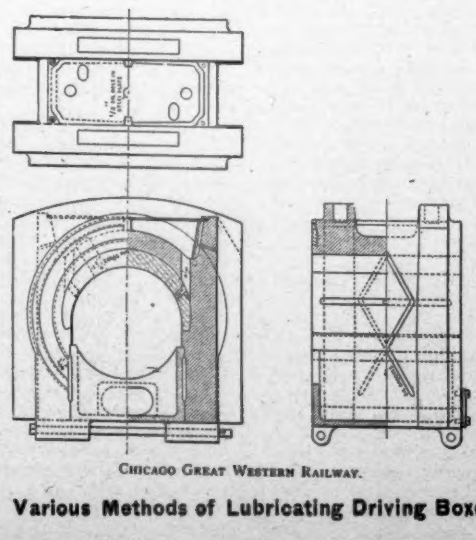
NORTHERN PACIFIC RAILWAY COMPANY.



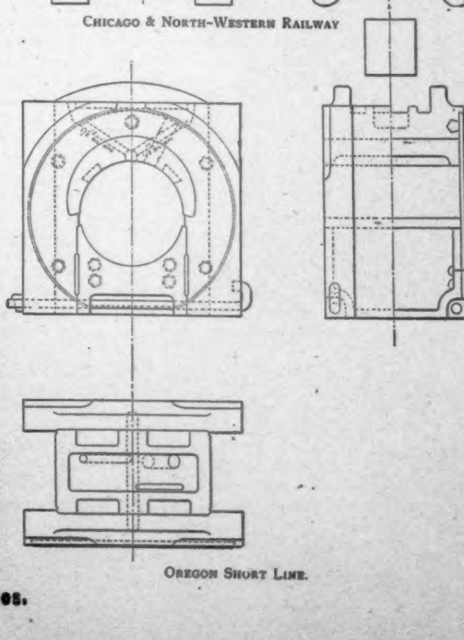
CHICAGO & NORTH-WESTERN RAILWAY



GRAND TRUNK RAILWAY SYSTEM.



CHICAGO GREAT WESTERN RAILWAY.



OREGON SHORT LINE.

Various Methods of Lubricating Driving Boxes.

exhaust side of the cylinder without transformation in proper proportion into work, will reduce this loss and increase the efficiency of the machine.

This is effected in compound locomotives by a limited expansion, submitting as far as may be necessary to cylinder condensation and re-evaporation, but then transferring the working steam, both the condensation and the re-evaporation, to a second cylinder, in which the latter portion may either do some work or balance its waste more or less fully.

The question of adoption of the compound engine for the usual work of the locomotive where speed, pressure or load, either or all, is expected to be variable, is complicated by the fact that it is impracticable to find cylinder proportions which will be permanently suitable. Notwithstanding this difficult feature in design, the demand for larger engines and the thin partition which divides a net profit from a loss in railway operation render it well-nigh imperative that a solution be found for this perplexing problem. The heavier a locomotive, the smaller is the relative boiler capacity that can be supplied.

The limit in steam production once reached, the required gain in power can be attained only by a more economical use of the steam generated, and if the compound has the advantage claimed by its advocates, it seems that it will of necessity be adopted. The advantages accruing from compounding may be summarized as follows:

1. Reduction of expansion in one cylinder and consequent reduction of internal waste. 2. Ability to adopt large ratios of expansion with light loads without wire drawing. 3. Reduced leakage in engine. 4. Reduction of depreciation of boiler. 5. Greater boiler efficiency. 6. Lighter blast, smoother draft, less waste, annoyance and danger from sparks ejected from locomotives. 7. Elevated limit of speed and power. 8. Reduced loss by tender and fuel haulage. 9. Greater uniformity of crank movements. 10. Larger efficiency of machine.

To offset these gains, there are losses which may be enumerated as follows:

1. Increased first cost. 2. Increased cost for repairs and maintenance of machinery due to multiplicity of parts and greater weight of reciprocating parts.

After a careful consideration of the question as it has been presented before the Association in previous years, it would seem that there has been a steady growth of sentiment in favor of the compound, not only for slow freight, but also for express service; that many of the failures in its early days were not those of a wrong principle, but of faulty design, which source of trouble has to a large extent been remedied.

In recent years the number of compound locomotives which have been placed in service by the different roads has made the possibility of obtaining comparative data as to their performance, relative to simple engines, rather less difficult than formerly. Many roads using both types of engines have tabulated the performance of their engines for long periods of time and in several cases exhaustive tests have been made to determine their relative merits. In view of this fact, the present committee did not feel called upon to treat the subject from this standpoint, but rather to determine as far as possible the general opinion concerning the compound among those having them under their care, and to secure figures showing what net gain, under actual service conditions, might be due to compounding.

In the proceedings of the Western Railway Club for March, 1899, appears a paper by Mr. E. M. Herr, giving the record of compound locomotives on the Northern Pacific Railway. The paper is of particular value, as the records cover a considerable period and are compared with the records of simple engines of the same class for a similar period. Mr. Herr states "the object of the paper is to endeavor to bring out some discussion as to the advisability or inadvisability of the use of compounds for heavy freight service. From my experience on the Northern Pacific road, my judgment is that it is advisable to use the compound locomotive in heavy freight service. I say advisable because of the economy in fuel, and as far as our experience went, no appreciable, or at least no important, increase in the cost of repairs. It certainly seems advisable to use a machine that shows a saving of from fifteen to twenty per cent. of fuel in regular service and no very great or even appreciable increase in cost of maintenance."

In the discussion which followed the reading of this paper, the subject of the advisability of using compounds for passenger service came up, and the prevailing opinion was that for fast heavy service they were economical engines to use. Attention was called to the fact that as the compound was a comparatively new machine, careful attention should be given it, the cause of failure in any part should be determined and the evil remedied; that the most of the failures are not those of the compound feature, but of parts common to both types of engines, but which in the compound might require a design differing from that common to good practice in the simple engine.

In view of the data presented and the expressed opinions in the answers to the circular of inquiry, the committee believes the following conclusions are justified:

1. Compound locomotives have not come into general use in America, but are gradually emerging from the experimental stage. 2. Compounds have been in use in freight service longer than passenger service and there are more in such service; but in recent years there seems to be a disposition to use them also for fast, heavy passenger service. The compound is not as well adapted to switching service as the simple engine. 3. The ton-mile system forms the basis of comparison between compound and simple locomotives. The average saving of the compound in coal consumption is 16.5 per cent. 4. The actual saving of the compound depends upon the price of coal. The greatest economy will be attained where the compound is worked continuously well up to its limit. The opportunity for saving is greater in freight service than in passenger. 5. The compound is not so flexible an engine as the simple. 6. There should be no difference in the size of drivers between the compound and simple engine in the same service. 7. The compound may be successfully pooled, if such practice is followed, with simple engines. 8. The rating for compounds should be no higher than simple engines of the same class, weight and steam pressure. 9. If it be desired to work the engine simple over maximum grades, the rating may be slightly higher for the compound than for the simple engine. 10. The correct ratio of cylinders is difficult to determine, as other factors than the determination of such ratio as will secure the minimum cylinder condensation enter the question. In the two-cylinder type it is of paramount importance that the work in both cylinders be equalized as closely as possible for all positions of the reverse lever. This is easier accomplished if the ratio be kept down, and in freight engines it seems that a ratio of about 2 1/3 to 1 would be acceptable, while for passenger a slightly higher ratio, 2.37 to 1, might be used. For the four-cylinder compound the most important question is that of equalizing the pressure on the high and low pressure pistons, and a ratio of 3 to 1 gives good results. 11. Manual control of compounding feature is preferable to the automatic. 12. There is no necessity for having any trouble due to the use of a large cylinder if proper care be used in the design of the piston. 12½. There is less danger of setting fires from the stack of the compound than of simple engines. 13. It is necessary to relieve the cylinders while drifting, large relief valves being used on four-cylinder compounds and the by-pass on two-cylinder compounds. 14. The piston valve is preferable to the slide valve, as more perfect balance is secured, and consequently less wear of valve and seat and less strain on valve motion. 15. When comparisons have been made between compound and simple engines, the pressures were usually the same. 16. In starting it is necessary to work the engine simple; that it is bad practice to so rate the engine that it will be necessary to work it simple over heavy grades. 17. Engineers are apt to abuse the privilege of working the engine simple. With the same supplies at hand for the repairs on compound engines, there is no necessity for the compound remaining out of service for repairs any longer than the simple engines. 19. The cost of boiler repairs is less on the compound and may average 19.6 per cent. less than for the simple engine. 20. The cost of maintaining the machinery on the compound is a little more than on the simple. 21. The cost of lubrication on the compound will be about 15 per cent. more than on the simple engine. 22. The compound will be an economical machine whatever the price of fuel. 23. More compounds are in use where the fuel is expensive than where it is cheap. 23½. There is no necessity for any difference in the size of the exhaust nozzle of the compound and that of the simple. 24. Many and careful comparisons have been made of the relative performance of the compound and simple engine, and the position of the compound in railroad economy may now be determined. 25. It is possible to build a compound that will give satisfaction equal in tractive power to any of the simple engines. 26. The low-pressure piston will give better results if made of cast steel with a bronze bearing ring cast in its periphery. 27. The most notable improvements have been in the intercepting valve, in steam distribution and better design of the machinery. 28. Attention is called to the necessity of further improvement in design of machinery, intercepting valve and steam distribution. 29. With the modern machines the compound holds its place as against the simple and it is not advisable to change any in use into simple engines.

PISTON VALVES.

Committee: S. P. Bush, Wm. McIntosh, H. Schlacks.

Two weeks after the appointment of the committee last year, a circular was prepared asking certain questions covering the use of piston valves in locomotives. This circular was sent to all the members of the Master Mechanics' Association, and while a comparatively small number of the members are using piston valves on their locomotives, yet it is found that a majority of those that have used the piston valve make replies which in nearly all cases are exceedingly favorable to the piston valve.

It is not the intention of the committee to go into all the numerous details of piston-valve constructions that have been tried, inasmuch as most of the variations are the result of individual opinions as to construction and do not affect the general result. The committee feels, however, that it can cover the important features in this report and speak with reasonable certainty. As stated previously, nearly all of those reporting as having had experience with the piston valve speak favorably of it, and this, in the judgment of your committee, is satisfactory evidence that it has merit.

The advantages of the piston valve are generally stated as follows:

For steam pressures exceeding 185 lbs. the piston valve offers considerably less resistance than the slide valve, thus reducing the work the entire valve gear must perform, and reduces the internal resistance of the locomotive, which is thought to be considerable in modern high-pressure engines.

For steam pressures higher than 185 lbs. the question of valve lubrication is very much simplified, and the difficulties of cut valves and seats are very much diminished.

The cost of maintaining the piston valve seems to be no greater than that of maintaining the slide valve. This statement is not based on a large number of figures, but rather on the judgment of those using the piston valve.

The area of admission and exit openings can be very materially increased with the piston valves, which, with higher power locomotives, seems to be a very important advantage; and it is well known that, in order to obtain the highest efficiency from a locomotive it is not only necessary to get steam into the cylinder promptly, but to get it out again.

These are, in short, the advantages of the piston valve that seem to have been demonstrated. The committee believes that, in adapting the piston valve to the simple engine, the internal admission type has possibly a slight advantage in that the loss of heat by steam is somewhat less than in the case of the external admission type.

Some railroads and locomotive builders, when designing valve gear for piston valves having internal admission, assumed that the valve gear as designed for external admission would answer for those with internal admission. Practice develops that this is a mistake, and that in order to obtain the proper steam distribution, the valve gear must be specially designed for the internal admission.

In designing the piston valve attention is called to the necessity of obtaining the benefit of all the area of admission and exhaust which the principle of the piston valve affords. The committee thinks that this has not always been taken advantage of to the full extent.

One point in piston-valve construction that has been found to have a material effect on steam distribution has been somewhat overlooked, namely, the difference in area between the forward and rear; the area of the rear end being reduced by the area of the piston rod; the two ends are therefore out of balance, and as a result the motion of the valve in one direction is deranged as compared with the motion in the other direction, inasmuch as the lost motion in the valve gear is taken up in an opposite direction from that which is ordinarily the case. This is based upon experiment on the part of the committee, and from the statement of an individual to the effect that a locomotive equipped with piston valves ran for quite a distance with one of the valve stems broken, the valve making its regular movement by being pushed ahead by the end of the broken valve stem in one direction, and pushed back again in the opposite direction by the excess pressure on the forward end of the valve.

The committee finds a great variety of packing used for piston valves. It can be said, however, with perfect certainty, that plain snap packing rings will give entirely satisfactory service.

TON-MILE BASIS FOR MOTIVE-POWER STATISTICS.

Committee—H. J. Small, C. H. Quereau. Mr. W. H. Marshall dissenting.

In the report of this committee presented at the 1899 meeting we argued at length that all the items involved in the Cost of Engine Service statement should be based on the ton-mileage produced. It is not our intention to present this matter at length in our present report, but wish to emphasize the conclusions reached in that report by an illustration taken from a performance sheet for January, 1900, in which is shown the records made on the mile and ton-mile bases.

	Moguls, Simple. 19 by 24.	Consolidat'ns, Compound. 21 by 31 by 24.	Per cent. in favor of Simple Engines.
Cost per *Mile*.	Cents.	Cents.	
Oil and waste	.24	.30	25
Fuel	14.81	15 84	7
Repairs and supplies	2.51	5.08	103
Wages	6 93	7.63	10
Total	24.49	28.83	18
			Per cent. in favor of *Compound* (except**).
Cost per 10,000 *Ton-Miles*.			
Oil and waste	$ .04	$ .03	33
Fuel	2.44	1.77	8
Repairs and supplies	.41	.58	40**
Wages	1.14	.85	134
Total	$4 03	$3.23	25

We believe the showing in the above tables a sound argument in favor of the use of the ton-mile basis, and for all the items making up the cost of engine service. We believe it advantageous to also have a statement showing the cost of engine lubrication and illuminating oils on the engine-mile basis.

Comparison of Statistics.

In our previous report we also argued that greater economies will be secured by comparing the statistics for a given system or division with those made by the same line in previous years, rather than with those of other roads, because when the comparison is made with other roads the conditions, which very largely control results, are, almost as a matter of necessity, so different that a just comparison can not be made, while this is not true when the comparison is with previous records made on the same line. In this report it is our intention to only emphasize this point and refer to our previous report for the extended argument.

What Service Should be Included?

The chief reasons for adopting the ton-mile basis for railroad statistics, in place of the mile basis, are that the former is a more accurate measure of the work done, and encourages economy in operating. We can see no good reason why these qualities are not as desirable for passenger service as for freight, though it will be admitted that greater economies will result in freight service. It is urged by some that the speed and weight of trains in passenger service are not within the control of division officials, implying that there is little use in trying to improve the records for this service, therefore there is no use in using the ton-mile basis for these statistics. This reasoning applies with equal force to a large proportion of freight service, such as stock, fruit express and fast merchandise, but is not considered to have sufficient weight to prevent the use of the ton-mile basis. We know that some men are more economical than others in passenger service, as well as in freight, and believe the use of the ton-mile basis is better than the engine-mile basis with which to determine their relative merits, and so encourage better records. It also seems to us desirable that both passenger and freight service statistics be on the same basis. This is apparently the view of nine out of the fourteen roads reporting, or nearly 65 per cent. To the actual weight of cars in passenger service we would suggest the addition of five tons for mail, baggage and express cars in main line service, three tons for such cars in branch-line service, and of two tons for such cars as carry passengers, whether in branch or main line service. Passenger cars hauled deadhead in freight trains should have no such credit.

Engines in work train and switching service are credited with an arbitrary number of miles per hour. We see no reason why they should not be credited with an arbitrary ton-mileage instead, which would give the same basis for the statistics of all classes of engine service which we believe is important and desirable. Nearly 22 per cent. of the roads reporting are of this opinion.

We would suggest that work engines be credited with the actual weight of their trains, to be determined on the same basis as for freight engines, and with ten miles per hour. If the weight of the train is 500 tons, and the engine is in service ten hours, the credit for the day's work would be 5,000 ton-miles.

For 18 by 24-in. switch engines carrying 145 pounds of steam pressure and having 50-in. driving wheels, we would suggest a credit of 200 tons and eight miles per hour. For a day of ten hours this would make a credit of 1,600 ton-miles. For other switch engines the tonnage should be proportional to their power as determined by the formula in the next paragraph.

The credit for pusher and double-heading engines should be made on the basis of the proportional power of the engines attached to the train. This is quite easily determined by means of a table which can be made in the drawing-room, from the tractive power formula.

We would sum the argument for the use of the ton-mile basis for all classes of engine service as follows: It is the most accurate practicable basis for measuring the work done in freight and passenger service; an arbitrary ton-mileage credit for switch engines is as accurate as an arbitrary mileage credit and has no disadvantages; for work engines a credit for the actual tonnage handled and an arbitrary mileage per hour is more accurate than a credit of an arbitrary mileage only; it is desirable to have the same basis for all classes of engine service.

What Tonnage Should be Included.

There are evidently differences of opinion as to what tonnage should be included in making statistics. Some are decidedly of the opinion that the entire weight of the train, including the engine, tender and way-car, should be used. Others contend, with equal conviction, that only the weight of the cars and their contents, excluding the way-car, should be used. It is quite possible that this difference of opinion may in some cases be due to a confusion of the terms "ton-mileage" and "tonnage rating." The ton-mileage of a locomotive for a given trip is ascertained by multiplying the weight of its train, reduced to tons, by the number of miles this tonnage is hauled. The tonnage rating of the same engine is quite a different matter, being simply the number of tons it is rated to handle, and does not necessarily have any relation to its ton-mileage. As the weight of a given engine and its way-car is always the same, there is no good reason why the tonnage rating should include these weights, as the object of the tonnage rating is simply to always secure a weight of train which shall be the greatest practicable under service conditions.

It may seem that this line of reasoning should be applied to the ton-mileage, and that, because there is nothing gained by including the tonnage of the engine and caboose in the tonnage rating, therefore it should not be included in the ton-mileage. It seems to your committee that this does not logically follow, because the object of the tonnage rating and that of the ton-mile basis for statistics are entirely distinct. The tonnage rating is used as a measure of the capacity of the locomotive, while the ton-mileage is intended to show the work actually done, regardless of whether the tonnage rating is handled or not, as a basis for the cost of engine service.

One of the favorite arguments of those who favor the exclusion of the ton-mileage of the engine and way-car is that

the management wants to know what their engines are hauling behind the tender. Admitting, for the sake of argument, that this position is correct, no better statement could be made to show that the weight of the way-car should be included in the ton-mileage.

It is argued that there are engines of modern design which will haul more tons of freight behind the tender for each ton weight of engine than others, which are not so well designed, and therefore the weight of the engine and tender should not be included in the ton-mileage, so as to make a better showing for the modern design. We question the relative importance of this information, believing that the cases where it would apply are comparatively limited, and that the desired information could be obtained more accurately either by calculation or special tests. In short, that it is more important that the motive-power statistics be based on a ton-mileage which will represent as nearly as practicable the total work returned for the money spent than to leave out of the account a considerable percentage of the work done for the sake of exceptional conditions.

It is claimed by some that the weight of engine and tender should be omitted on the same basis that the owner of a stationary engine wishes to know the power delivered by the fly-wheel rather than the total power developed in the cylinder. The cases are quite different. The power absorbed by the stationary engine is simply that necessary to overcome the internal friction, amounting possibly to eight per cent. of the total developed, and it does not run without a load. With a locomotive, in addition to the internal friction, there is the power absorbed in moving its own weight, which frequently, even with its maximum load, amounts to 35 per cent. of the total power developed. In rating and judging the efficiency of a stationary engine both its owner and builder include in the work performed that absorbed by the shafting which it drives, amounting frequently to 50 per cent. of the total power developed, and frequently that absorbed by internal friction. It would seem that those who advocate the omission of the ton-mileage of the locomotive and its tender can find scant grounds for their postition from stationary practice.

Viewing the matter from a strictly motive-power standpoint, we are of the opinion that the ton-mileage should include the entire train—the engine, the cars with their contents, and the way-car. The strongest argument in favor of this view is that the best basis for determining motive-power costs is that which includes all the work produced by the money spent. The management is specially interested in knowing the cost of hauling a ton of paying freight one mile. This would exclude from the ton-mileage that of the engine, the light weight of the cars, including the way-car, and of company material. It is exceedingly doubtful if any motive-power official will claim this is a proper basis from which to find out whether his department is being managed economically or not, simply because it evidently would not furnish an accurate measure of the work done by the money spent. As it would give no credit for work done in hauling empty cars, company material, for an engine and way-car, or for a light engine, we would justly argue that statistics on such a basis could not fairly be used to measure our efficiency as motive-power officials, and would be of little practical use in helping us to reduce costs intelligently. Empty cars and company material must be hauled; locomotives with only a caboose, and without a caboose, must run over the road; this work necessitates an expenditure of money by the motive-power department and is in no way under its control. Is it not reasonable to claim that there should be a credit for this unproductive work against which to charge the money spent in doing it?

Under the head of "Statistics" it is worth noting that, of the fourteen roads reporting, on all but one the operating department uses the ton-mile basis for their statistics. The needs of the operating and motive-power departments in this matter are quite different. The operating department wishes to know the per cent. of empty to loaded ton-mileage, the per cent. of actual to rated ton-mileage, the average tonnage of load per car, so that the per cent. of useful work may be increased. On the other hand, these matters are of minor interest to the motive-power official, and then only as they affect the efficiency of his department. The motive-power officer is interested in knowing the actual work performed, not with a view of bettering the efficiency of the operating department, but his own.

If our statement of the case is correct, it follows that there are three interests to be served by ton-mileage statistics: Those of the management, which wishes to know the cost of handling a ton of freight one mile; those of the motive-power department, which we believe is entitled to a credit for all the work performed by the money it is responsible for; and those of the operating department, which finds the ton-mile basis the best practical one for reducing the per cent. of unproductive work in handling their trains. If this is a fair statement of the case, it follows that the needs of no two of the departments are the same, and therefore a compromise will serve the best interests of neither. It will be admitted that the management is interested in the statistics of both the other departments, but we venture to assume we are warranted in believing that it is to the best interests of the management to allow each such a basis for their statistics as will favor its greatest efficiency.

There is an opinion, judging by editorial comments and personal remarks, that the expense for the three statements which we advocate will be prohibitory. We believe that a study of the facts will show that such is not the case. For the motive-power ton-mileage the addition of that for the engine and way-car will cost practically nothing, as will be readily understood when attention is called to the fact that these are constants for any given district and will not have to be figured out for each trip. For instance: A 15-ton caboose going over a 120-mile district will have a ton-mile credit of 1,800 for each trip; a 200-ton engine on the same district will have a credit of 24,000 ton-miles for each trip; and on each district there will be such a constant. The additional expense for adding these constants to the footing of the ton-mileage for the operating department, which should not include them, will be scarcely appreciable. On one road the ton-mileage of the engine is added in the office of the Superintendent of Motive Power, where the weight of each engine and its mileage are known.

It is probable that the ton-mileage statistics of the operating department should show separately that for the lading, for the loaded cars, for the empties, and east and west bound traffic in order to be of the greatest usefulness. If this is correct, it follows that the additional expense for furnishing the ton-mileage for the management, which should show only that for the contents of the cars, would be only that necessary to draw off these figures as a separate statement from among the totals needed by the operating department. It would therefore appear that the expense for ton-mileage figures for each department, best suited to its uses, would be but very little greater than for a compromise statement which would serve the best interests of neither.

The preceding argument has referred only to the expense for compiling the ton-mileage. We believe it safe to assume that the expense for figuring out the statistics based on ton-mileage will, after the first year, be no greater than it has been for furnishing the corresponding statistics on the mile basis. This has been the experience of others and seems a reasonable proposition. If the ton-mile statistics are more elaborate, it will follow that the expense will be somewhat increased. In this connection it is worth noting that for the first year the ton-mile statistics are used; it will be necessary to keep those based on the mile, if a comparison of one year with another is desired.

Conclusions and Recommendations.

The ton-mileage for the use of the motive-power department should include the weight of the entire strain.

For the use of the operating department it is probable that all that is needed is the weight between the tender and way-car.

The best interests of both departments will be best served by a joint committee representing both.

For the Motive-Power Department.

We recommend that all the items making up the cost of engine service be on the ton-mile basis;

That the statistics of all classes of engine service be on the same basis;

That in passenger service five tons for mail, baggage and express cars in main-line service, three tons for such cars in branch-line service, and two tons for all cars carrying passengers, be added to their scale weights; passenger cars handled deadhead in freight service should have nothing added to their scale weight;

That engines in work train service be credited with the actual weight of the entire train, to be determined on the same basis as for freight engines, and with ten miles per hour;

That switch engines having 18 by 24-in. cylinders, carrying 145 lbs. steam pressure and having driving wheels 50 in. outside the tire, be credited with 200 tons and eight miles per hour; for others the tonnage should be in proportion to their power, compared with that of the standard, and eight miles per hour;

That for pusher and double-heading service the credit for each engine attached to the train be its proportion of the ton-mileage, based on its power, for the distance covered by each;

That it is desirable to group the individual fuel statement and oil statement, each service by itself;

That the statistics for main line and branches be separate;

That the weight of the contents of freight cars handling way freight should be that with which it left the terminus;

That the ton-mileage of mixed trains, where both freight and passengers are handled in the same train, should be credited to that service which is entitled to the greatest per cent. of it;

That the tonnage of a locomotive should be its weight in working order plus that of the tender with half its capacity of coal and water.

RELATIVE MERITS OF CAST-IRON AND STEEL-TIRED WHEELS.

Committee—J. N. Barr, A. M. Waitt, H. S. Hayward, A. L. Humphrey, John Hickey.

The only report giving data has been received from the Union Pacific Railroad, in which they state that the average cost of mileage of 33-in. cast-iron freight car wheels is 8 cents per thousand miles; the average cost of steel-tired wheels is 45 cents per thousand miles.

Mr. G. W. Rhodes, of the Burlington & Missouri River Railroad, advises that he is of the opinion that 33-in. cast-iron wheels made to the M. C. B. standard test is a safer wheel than some of the steel-tired wheels on the market.

Under these circumstances, your committee is unable to add anything additional to the report printed in last year's proceedings.